No. 4 nonessential ac buses are not energized due to an electrical interlock with the auxiliary external power contactor circuit.

If desired, or if full air conditioning is required, the AUXILIARY receptacle can be utilized by connecting an additional lead from the same power source or from a power source synchronized with the first one.

CAUTION: DO NOT USE A SEPARATE POWER SOURCE, UNLESS SYNCHRONIZED, AS POWER LINES ARE INTERCONNECTED IN THE AIRPLANE. BE SURE THE POWER CART IS CAPABLE OF SUPPLYING THE REQUIRED LOAD.

If the auxiliary receptacle is energized and the external power switch is OFF, the auxiliary-connected (AUX CONN) light on the ac control panel and the auxiliary ON light at the receptacle illuminate. When the external power switch is turned ON, the MAIN ON BUS and AUX ON BUS lights on the ac control panel illuminate. Power is now available on the sync bus and all load buses, including the No. 1 and No. 4 nonessential ac buses.

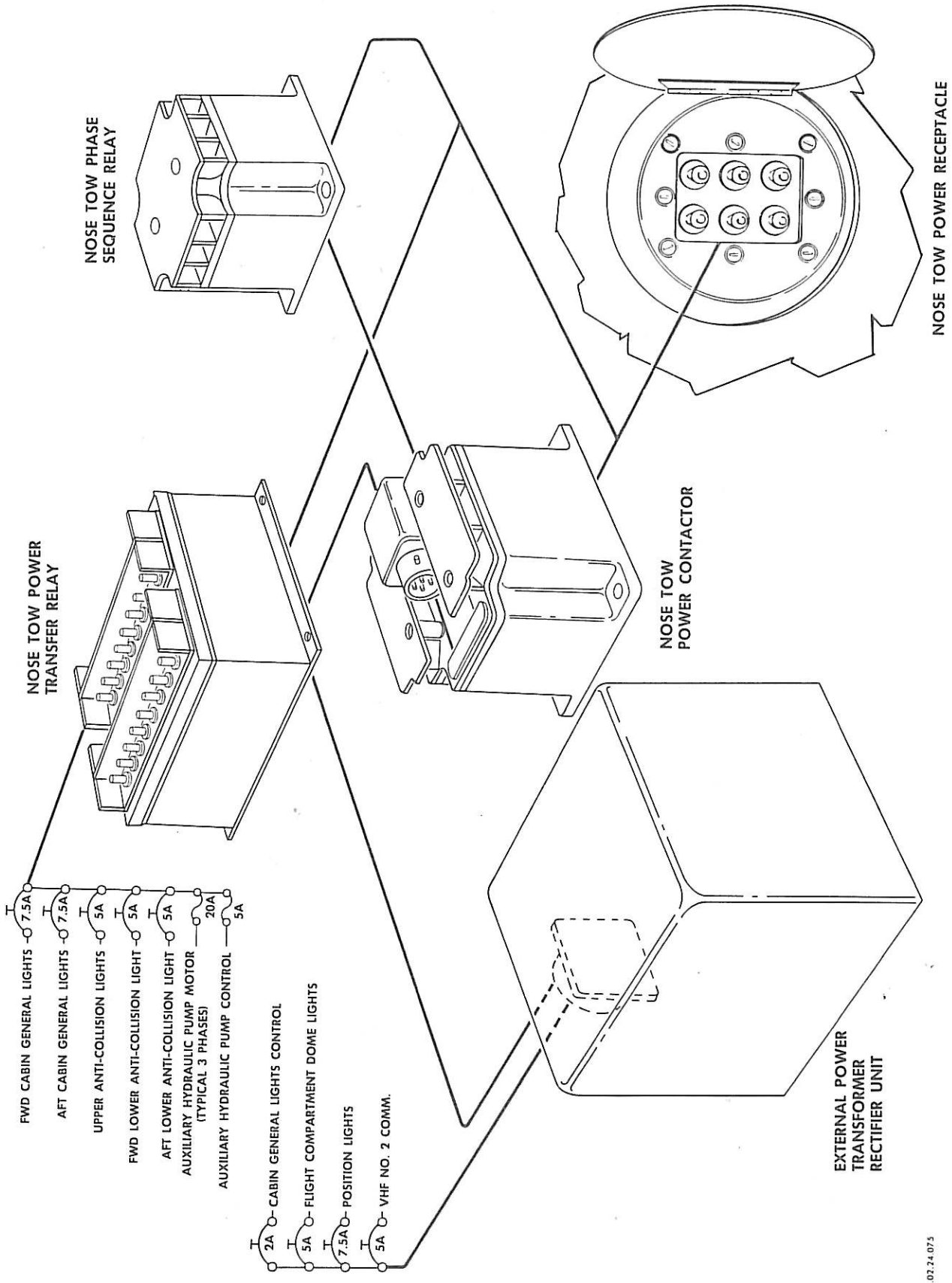
The airplane electrical power system is now being supplied full power from the external power system. When the first engine is started, electrical operations start shifting from external to normal power. As the first engine reaches an approximate speed of 3700 rpm, the underspeed switch closes. This switch indirectly controls the generator field flashing circuit. When generator buildup is complete, the applicable generator bus tie contactor opens and the generator line contactor closes. This action allows the generator to supply its own load bus; the external power system supplies the sync bus and all other load buses. As each remaining engine starts and the generators are energized, each assumes the load on its respective load bus. The sync bus remains energized from the external power system. The external power switch is placed in the OFF position, deenergizing the two external power contactors; both the MAIN and AUX ON lights extinguish. The external ac power unit can then be deenergized and the plugs removed. When the plugs are removed, the complete external power system deenergizes and all warning lights for the system extinguish.

3. Nose Tow Power System (see Figure 4)

(Applicable to airplanes equipped with a nose tow power receptacle)

The nose tow power system consists of a nose tow power receptacle, a nose tow phase sequence relay, a nose tow power contactor, a nose tow power transfer relay, and the transformer-rectifier common to the external ac power system. The nose tow power receptacle is located on the forward right side of the fuselage at station 198 and the nose tow phase sequence relay and power contactor are located inside the fuselage near the receptacle. The power transfer relay is located in the external power junction box. The external power system and the nose tow power system are interconnected so that power cannot be applied to airplane circuits by both systems simultaneously.

A. Operation and Distribution. When a plug from the tow unit is connected to the nose tow power receptacle, and the unit is delivering power, the

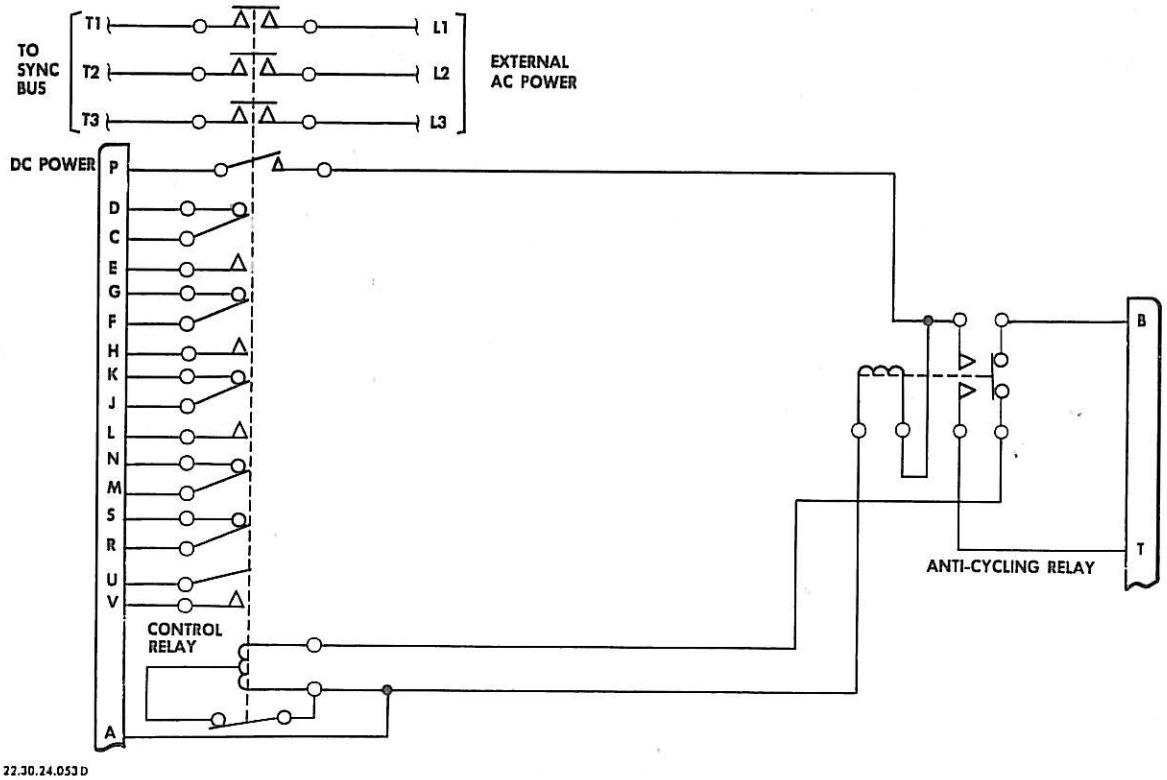


Nose Tow Power Block Diagram
Figure 4

nose tow power system is energized. Three-phase power from the nose tow power receptacle routes to the nose tow phase sequence relay, to the open contacts of the nose tow power contactor, and to the open contacts of the nose tow power transfer relay. If phase rotation and voltage are correct, a set of contacts in the phase sequence relay close and route 115-volt ac to the coil of the nose tow power contactor. The ground circuit for this coil is connected through a set of normally-closed contacts in the main external power contactor to prevent operation of the nose tow power contactor when the external ac power system is energized. As long as these contacts are closed, the nose tow power contactor energizes. This allows 115-volt ac from ØB of the nose towing ac power bus to energize the nose tow power transfer relay. This relay action routes 3-phase ac power to the external power transformer-rectifier unit. Transformer-rectifier output supplies dc power to various radio and electrical circuits needed during towing; dc power is also routed back to the external power unit to maintain holding contacts for ac output. Circuits requiring ac power from the nose tow receptacle are connected to the nose towing ac power bus directly or through the power transfer relay.

4. Power Contactors (see Figure 5)

The power contactors control power flow between the external ac power unit and the airplane ac distribution system. The main and auxiliary contactors in the external ac power system interconnect in such a manner that the main contactor must be energized before the auxiliary unit. The auxiliary unit



is used only when full ground air conditioning is required or power is required from the nonessential buses.

CAUTION: DO NOT USE SEPARATE POWER SOURCES UNLESS SYNCHRONIZED TO SUPPLY THE TWO PLUGS AS THE LINES ARE INTERCONNECTED IN THE AIRPLANE. BE SURE THE GROUND UNIT IS CAPABLE OF SUPPLYING THE AIRPLANE LOADS.

The main phase sequence relay supplies power to the coil of the main contactor. If phase rotation of the external ac power unit is not correct, the contactor will not energize. If the phase rotation is correct and the external power control switch is placed in the ON position, the contactor closes, and external ac power is connected to the sync bus. The auxiliary contactor operates in much the same manner except the ground for the contactor coil is obtained through a set of contacts in the main contactor rather than from the external power control switch.

The contactor in the nose tow power system contains only one ac coil and three sets of contacts for 3-phase power control to the nose towing ac power bus. Coil power is supplied through contacts of the nose tow phase sequence relay and energizes the coil as soon as power is connected to the nose tow receptacle. The nose tow contactor cannot be energized if the main external power contactor is energized because the ground circuit for the nose tow contactor is routed through a set of normally-closed contacts in the main power contactor.

5. External Power System Warning Lights

The external power system incorporates a number of warning indication lights (refer to Section 24-2-0, Figure 2) for use by the flight engineer and maintenance crew. These lights incorporate an integral test contact to determine if the test system is operative and the bulb is good. Test by depressing the bezel covering the bulb; the bulb should illuminate. The following paragraphs give a brief description of the lights:

A. Main Connected Warning Light. This white light is located on the ac generator control panel and is labeled MAIN CONN. It illuminates whenever the external power unit is connected to the main receptacle and is delivering proper output. The position of the external control switch has no effect on the operation of this light.

B. Main On Warning Light. This blue light is located on the ac generator control panel and is labeled MAIN ON BUS. It illuminates only when the external power unit is supplying power to the sync bus and the external power control switch is ON. At all other times this light is extinguished.

C. Auxiliary Connected Warning Light. This white light is located on the ac generator panel and is labeled AUX CONN. It illuminates whenever the external power is connected to the auxiliary receptacle and is delivering proper output. The position of the external power control switch has no effect on the operation of this light.

D. Auxiliary On Warning Light. This blue light is located on the ac generator control panel and is labeled AUX ON BUS. It illuminates when both the main and auxiliary power plugs are connected and receiving power from the external power unit and the external power control switch is ON. At all other times this blue light is extinguished.

E. External Receptacle Power On Lights. There are two white warning lights located in the external power receptacle opening, one is associated with the main receptacle and the other with the auxiliary receptacle. These lights do not have the press-to-test feature and operate only from the external ac power source. The lights illuminate whenever the respective receptacle is receiving power from the external power unit.

6. External Power Receptacles

The MAIN and AUXILIARY external power receptacles are located on the forward right side of the airplane, below and forward of the forward service door adjacent to each other in a recessed portion of the fuselage. From a position facing the opening, the MAIN receptacle is on the left or aft, and the AUXILIARY on the right or forward. When the receptacles are not in use, the opening is covered by an access door hinged on the forward end. *The nose tow power receptacle is located on the forward right side of the fuselage at station 198. *The nose tow power receptacle is mounted similar to the main and auxiliary external power receptacles. The receptacles are the connecting point between the ground power unit and the airplane circuits.

The main receptacle is normally the only one required for supplying airplane electrical loads on the ground. It will supply enough power to operate all essential airplane circuits. If, however, some nonessential circuits must be operated or when full ground air conditioning is necessary, the auxiliary receptacle must also be used.

CAUTION: POWER TO THE AUXILIARY RECEPTACLE MUST BE OBTAINED FROM THE SAME POWER SOURCE USED FOR THE MAIN RECEPTACLE OR FROM A SYNCHRONIZED SOURCE.

*The nose tow receptacle provides power to the ac and dc circuits required when the airplane is towed. *Essential and nonessential load buses cannot be energized from the nose tow power system.

7. Phase Sequence Relay (see Figure 6)

The main and auxiliary phase sequence relays are located in the electrical compartment, in the external power junction box (refer to Section 24-0, Figure 2). *The nose tow phase sequence relay is located at station 198 near the nose tow power receptacle. The units consist of a relay (with two actuating coils), two rectifier units, resistors and capacitors.

*Applicable to airplanes equipped with a nose tow power receptacle.

The phase sequence relays perform two primary functions in the ac system as follows:

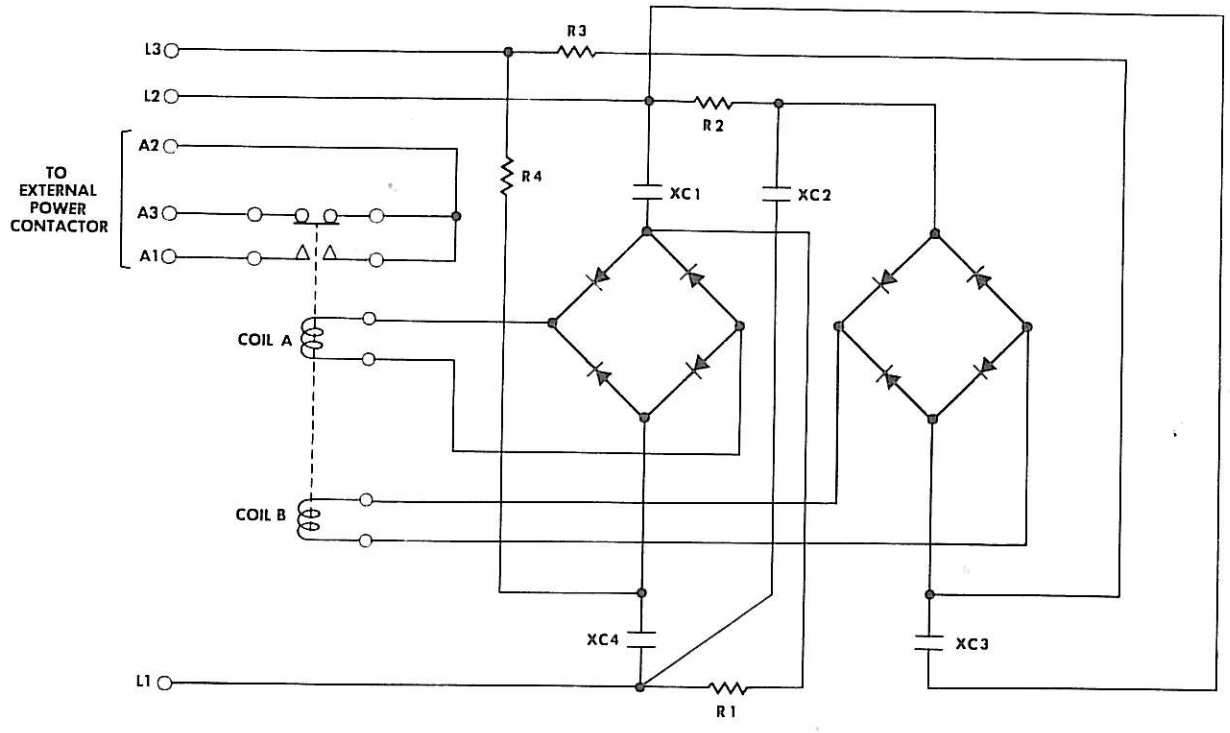
A. Allows the associated power contactors to energize only if the phase rotation of the external ac power unit is correct.

B. Detects undervoltage, resulting from a short circuit.

The phase sequence relays allow the contactors to energize if phase rotation is correct (in this case L1-L2-L3) and if the balanced 3-phase voltages are 100 volts line-to-neutral or higher.

The two relay coils (A and B) provide the magnetic flux to open or close the contacts. The flux from one coil is in opposition to the other, therefore if the voltage applied to coil A is greater than that applied to coil B, the relay armature moves in one direction, closing the normally open contacts. Closing these contacts energizes the external power contactor. Conversely, if the voltage to coil B is equal to or greater than that of coil A, the armature will remain in the position shown and the external power contactor does not energize.

These units provide secondary functions of fault protection in the external power and nose tow power systems, such as protection from high or low voltages, open phase and from faults on the sync bus or nose towing ac power bus.



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Phase Sequence Relay Schematic
Figure 6

8. External Power Transformer-Rectifier (refer to Section 24-5-0, Figure 4)

The external power T-R unit mounts on top of the external power junction box in the electrical compartment. The unit requires a 115/200-volt, 3-phase, 400-cps, 4-wire grounded neutral ac input and has an output rating of approximately 28 volts at 50 amperes. The units consist of transformers, rectifiers and other electrical components to maintain proper output voltages.

This unit supplies dc power for airplane circuits during ground maintenance *and during towing. It also supplies dc power to the bus tie contactors, the bus tie control relays and the bus power relay until the airplane dc buses are energized during external ac power operation.

*Applicable to airplanes equipped with a nose tow power receptacle.

EXTERNAL AC POWER SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. MAIN EXTERNAL AC POWER CONTACTOR FAILS TO CLOSE WITH THE EXTERNAL POWER CONTROL SWITCH IN THE ON POSITION	
A. Defective bus tie contactor.	Check continuity through applicable contacts of the four bus tie contactors. If no continuity, replace defective unit and check operation.
B. Defective external power T-R unit.	If input voltage is good, check for proper output voltage on applicable limiter in the external power junction box or at unit. If output voltage is not correct, replace unit and check operation.
C. Defective phase sequence relay.	Check for power on terminals A1 and A2 with phase sequence relay energized. If power is present on A2 but not A1 replace relay and check operation. If no power is present on A2 check external power T-R unit output, refer to preceding step B.
D. Defective external power contactor.	Check for power on pin B of contactor plug. If power is present and ground connection is good (see step G) replace contactor and check system operation.
E. Defective external power control switch.	Check continuity through switch contacts with switch in the ON position. If no continuity, replace switch and check operation.
F. Phase rotation of external power unit is incorrect.	Check external power unit phase rotation with a phase sequence box. If rotation is incorrect, obtain a tested replacement.
G. Defective circuit wiring.	Check circuit wiring from external power control switch fulcrum to ground connection. If no continuity, repair or replace wiring and check operation.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
4. AUXILIARY CONNECTED LIGHT FAILS TO ILLUMINATE WITH AUXILIARY RECEPTACLE CONNECTED AND EXTERNAL POWER UNIT OPERATING	
A. Defective bulb.	Check light assembly press-to-test feature. If bulb does not illuminate, replace and check operation.
B. Defective dimming relay.	Check for continuity through associated dimming relay contacts. If no continuity, replace relay and check operation.
C. Defective light assembly.	Check light assembly for loose or shorted terminals. If faulty replace assembly and check operation.
D. Defective auxiliary external power contactor.	Check for a ground on plug pin B of auxiliary contactor with main contactor energized. If a ground is present, replace auxiliary contactor and check operation.
5. *NO POWER AT NOSE TOWING AC BUS WITH TOW POWER PLUG CONNECTED AND POWER UNIT OPERATING	
A. Main external power connected and energized.	Turn external power control switch OFF and disconnect main external power plug. Check operation.
B. Open limiter(s).	Check associated limiters. If open replace limiter(s).
C. Defective phase sequence relay.	Check for voltage at terminal A2. If no voltage replace relay.
D. Defective nose tow power contactor.	Check for continuity between terminals X1 and X2. If no continuity replace unit.
E. Defective wiring.	Check circuit wiring for continuity. If no continuity repair or replace defective wire(s).

*Applicable to airplanes equipped with a nose tow power receptacle.

EXTERNAL AC POWER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test External AC Power System

A. General.

The external ac power system uses two external power receptacles stenciled MAIN and AUXILIARY. The main receptacle supplies power to the airplane essential ac buses. If nonessential buses are to be energized, the auxiliary receptacle must be plugged in. It is not possible to use only the auxiliary receptacle because control circuitry for the auxiliary external power contactor is routed through a set of normally-open contacts in the main external power contactor. Therefore the main contactor must be energized before the auxiliary unit can be used. *A nose towing receptacle provides ac and dc power to a limited number of circuits during airplane towing.

CAUTION: DO NOT USE A SEPARATE EXTERNAL POWER UNIT FOR THE AUXILIARY RECEPTACLE, UNLESS SYNCHRONIZED, AS POWER LINES ARE INTERCONNECTED IN THE AIRPLANE. BE SURE THE POWER UNIT IS CAPABLE OF SUPPLYING THE REQUIRED LOAD.

B. Equipment Required - External ac power unit.

C. Preparation.

(1) Check the following switches for positions indicated:

(a) Battery switch - OFF.

(b) T-R switches No. 1, 2, 3 and 4 - OFF.

(c) DC voltmeter selector switch - OFF.

(d) Load reduction switch No. 1 and 4 - OFF.

(e) 26-volt ac power selector switch - MAIN.

(f) External power control switch - OFF.

(g) Generator disconnect switches No. 1, 2, 3 and 4 - NORMAL.

(h) Bus tie control switches No. 1, 2, 3 and 4 - OPEN.

(i) Generator line control switches No. 1, 2, 3 and 4 - OPEN.

(j) Frequency/Voltmeter selector switch - OFF.

(k) Generator control switches No. 1, 2, 3 and 4 - OFF.

*Applicable to airplanes equipped with a nose tow power receptacle.

(l) Pilots' ac essential bus selector switch - EXT PWR.

(m) Essential bus relay switch - NORMAL.

D. Test External AC Power System.

(1) Connect external power unit plugs to airplane MAIN and AUXILIARY external power receptacles. The MAIN and AUXILIARY CONN indicator lights on the flight engineer's ac generator control panel, and the main power on and auxiliary power on indicator lights at the external power receptacle opening shall illuminate.

(2) Place ac frequency/voltmeter selector switch in the EXT PWR position.

(a) Voltmeter shall indicate 115 (±2.0) volts.

(b) Frequency meter shall indicate 400 (±4.0) cps.

(c) The reading at all other frequency/voltmeter selector switch positions shall be zero.

(3) Close the following circuit breakers:

(a) 26-volt AC INSTR BUS CONT AND IND.

(b) AC INSTR POWER FAIL LTS.

(c) BATT REL CONT.

(d) GEN AC SYS IND LTS 1 and 4, 2 and 3.

(e) GENERATOR AC POWER CONT 1, 2, 3 and 4.

(f) MASTER AND WARN LTS CONT.

(g) MASTER WARN.

(4) Place external power control switch and T-R 4 control switch ON.

(a) Flight engineer's MAIN and AUXILIARY ON BUS indicator lights shall illuminate.

(5) Place frequency/voltmeter selector switch in first the SYNC and then the EXT PWR position.

(a) Ac voltmeter shall indicate 115 (±2.0) volts.

(b) Frequency meter shall indicate 400 (±4.0) cps.

(6) Place the following switches in the indicated positions:

(a) T-R switches 1, 2 and 3 - ON.

(b) Pilots' ac essential bus selector switch - EXT PWR.

(c) Bus tie control switches No. 1, 2, 3 and 4 - ON.

(d) Load reduction switches for bus No. 1 and 4 - NORMAL.

(7) Check the system warning lights for the configuration indicated:

(a) Four generator OFF lights - Illuminated.

(b) Four generator OVERHEAT lights - extinguished.

(c) Four generator line contactor OPEN lights - illuminated.

(d) Four generator bus tie contactor OPEN lights - extinguished.

(e) Four DRIVE MALFUNC lights - extinguished.

(f) Two load reduction OFF lights - extinguished.

(g) Battery CHARGER RELAY OPEN light - illuminated.

(h) 28-volt dc essential bus OFF light - extinguished.

(i) 28-volt dc emergency bus OFF light - extinguished.

(j) 26-volt MAIN OUT and STANDBY OUT lights - extinguished.

(k) Instrument power failure light, copilot panel - extinguished.

(l) Essential bus fail light, pilot panel - extinguished.

(8) Rotate the dc voltmeter selector switch to BATT, TR-1, TR-2, TR-3 and EMER TR-4 positions. DC voltmeter shall indicate 24.5 to 28 volts at each position.

(9) The four T-R ammeters shall read between 1 and 10 amperes.

(10) All ac and dc power supply load buses shall be energized from the external ac power supply system.

(11) Deenergize the external ac power system by turning the external power control switch to the OFF position. All indicator lights in the flight compartment except the MAIN and AUX CONN indicator lights shall extinguish.

(12) Return all airplane control switches to the positions indicated in paragraph C., Preparation.

(13) Open all circuit breakers closed in step D.(3).

(14) Turn external power unit off. The main and auxiliary power on lights at the external power receptacle opening shall extinguish.

2. Adjustment/Test Nose Tow Power System

(Applicable to airplanes equipped with a nose tow power receptacle)

A. General.

The nose tow power system operation is automatic with the external control switch in OFF. This system only supplies power to the nose towing ac power bus for operation of the auxiliary hydraulic pump and to various circuit breakers, for lights and radio communications, through the nose tow power transfer relay.

B. Equipment Required - External AC Power Unit.

C. Preparation.

(1) Check that the external ac power control switch is OFF.

(2) Check that the circuit breakers for the required airplane systems are open. (Close these circuit breakers if the systems are to be checked.)

D. Test Nose Tow Power System.

(1) Connect the external ac power unit plug to the nose tow power receptacle and energize the external ac power unit.

(2) Check that power is present in the following places or check operation of the applicable circuit:

(a) Nose towing ac power bus (115-volts ac at each phase).

(b) Forward and aft cabin lights circuit breakers (115 volts ac).

(c) Three anticollision lights circuit breakers (115 volts ac).

(d) VHF No. 2 communications receiver and transmitter circuit breakers (115 volts ac).

(e) Position lights circuit breaker (28 volts dc).

(f) VHF No. 2 communications receiver and transmitter circuit breakers (28 volts dc).

(g) Flight deck dome lights and cabin lights control circuit breakers (28 volts dc).

(3) Turn off external ac power unit and remove plug from nose tow receptacle.

EXTERNAL POWER CONTACTOR - MAINTENANCE PRACTICES

1. Removal/Installation External Power Contactor (see Figure 201)

   A. Equipment Required - None.

   B. Remove External Power Contactor.

      (1) Check that an external power unit is not connected to power receptacle.

      (2) Remove fiberglas cover over external power receptacle in floor of electrical compartment.

      (3) Remove bus bars and wires from contactor.

      (4) Remove screws attaching contactor to external power junction box.

   C. Install External Power Contactor.

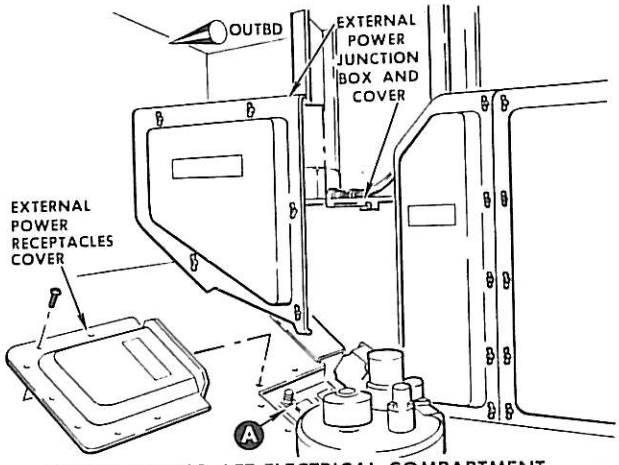
      (1) Place unit in proper position and install mounting screws.

      (2) Replace wiring and bus bars.

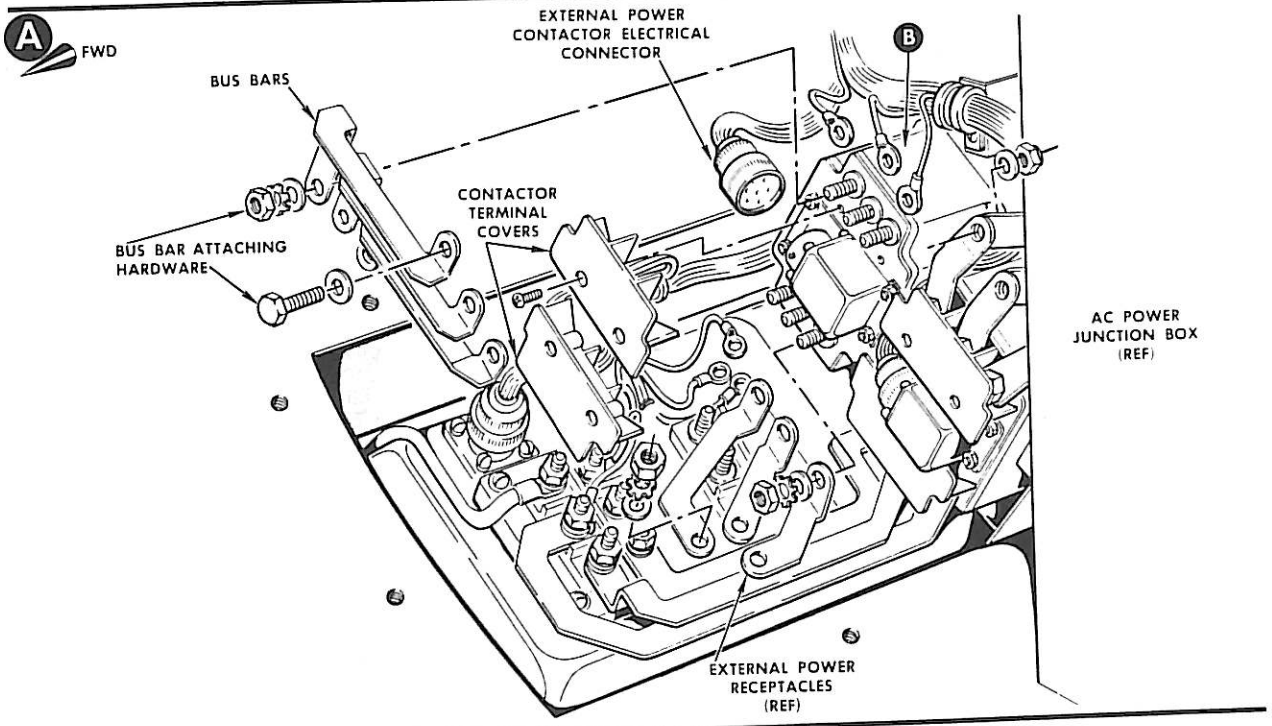
      (3) Replace cover over external power receptacles and install screws.

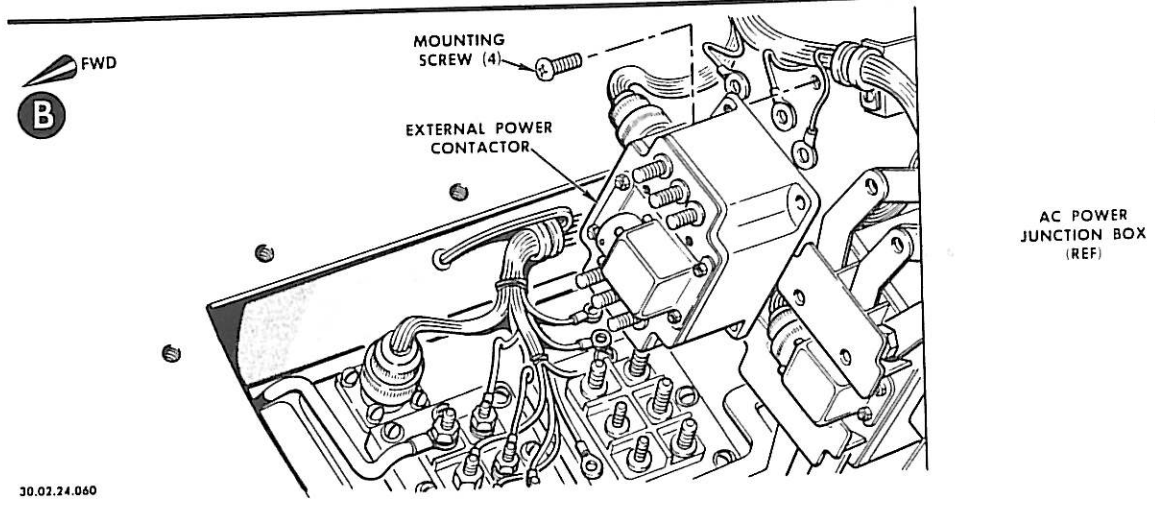
      (4) Energize the external ac power system.

      (5) Test system operation (refer to Section 24-3-0, Adjustment/Test).



VIEW LOOKING AFT ELECTRICAL COMPARTMENT





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External Power Contactor Installation
Figure 201

EXTERNAL POWER RECEPTACLES - MAINTENANCE PRACTICES

1. Removal/Installation External Power Receptacles (see Figure 201)

   A. Equipment Required - EC 1293 Sealant (or equivalent).

   B. Remove External Power Receptacle.

      (1) Remove airplane power.

      (2) Remove screws securing fiberglas cover over inboard side of receptacles, located in the floor on the aft right side of the electrical compartment.

      (3) Remove wires and bus bars attached to studs.

         NOTE: The guard blocks, that prevent misalignment of the ac external power unit plug, are attached with the left-hand, top and bottom receptacle mounting screws. The guard blocks must be installed with the replacement receptacles.

      (4) Remove screws and nuts attaching receptacle to mounting plate.

      (5) Clean EC 1293 sealant from mounting surface (refer to Chapter 51, STRUCTURES GENERAL).

   C. Install External Power Receptacle.

      (1) Place external power receptacle and guard block in position and install mounting screws.

      (2) Replace nuts.

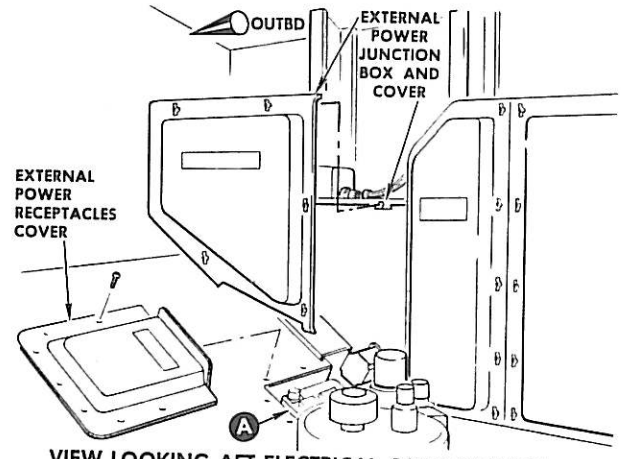
      (3) Attach wires and bus bars.

      (4) Apply EC 1293 sealant (refer to Chapter 51, STRUCTURES GENERAL).

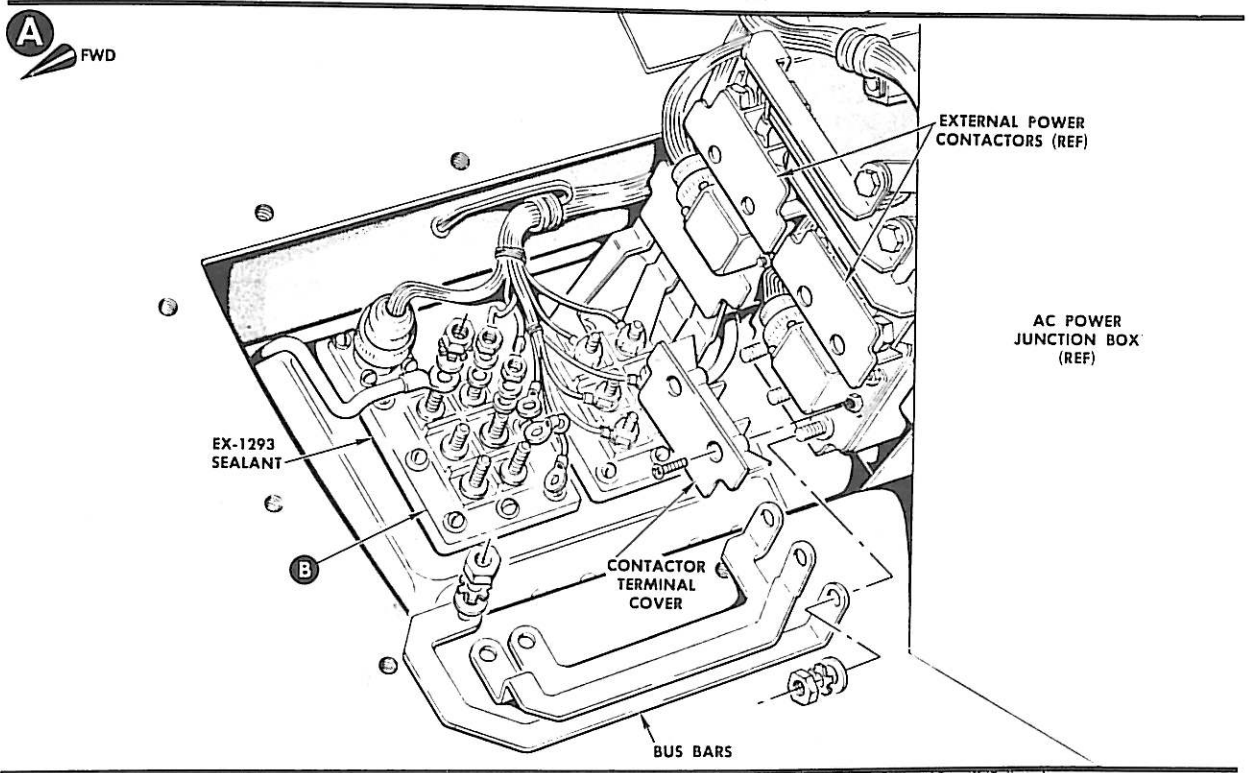
      (5) Replace fiberglas cover.

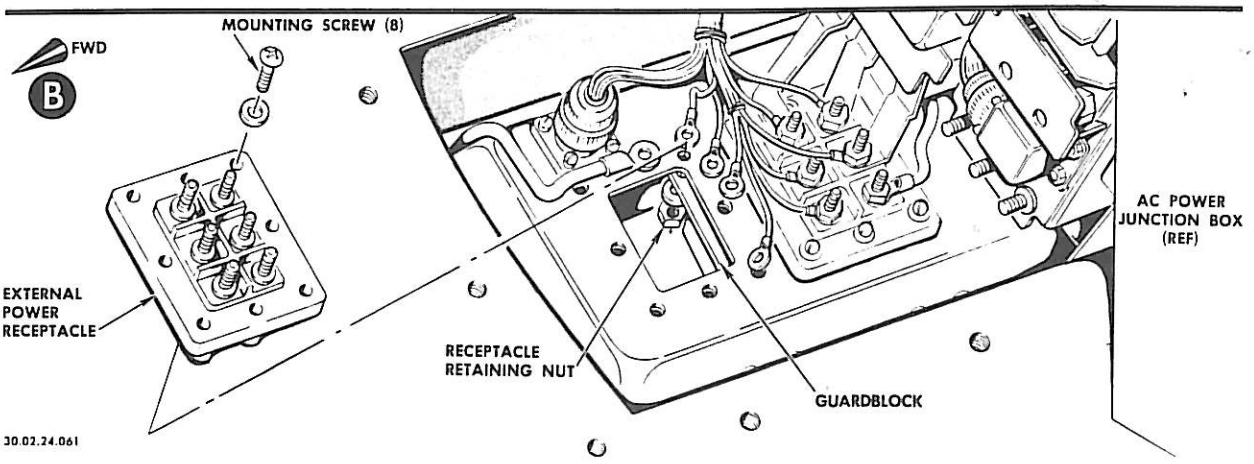
      (6) Energize external ac power system.

      (7) Test system operation (refer to Section 24-3-0, Adjustment/Test).



VIEW LOOKING AFT ELECTRICAL COMPARTMENT





PHASE SEQUENCE RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Phase Sequence Relay (see Figure 201)

   A. Equipment required - None.

   B. Remove Phase Sequence Relay.

      (1) Check that an external power unit is not connected to the external power receptacle.

      (2) Remove snap-on cover over relay terminal studs.

      (3) Remove wires from relay terminal studs.

      (4) Remove four mounting screws.

      NOTE: Identify screw under which bonding jumper is installed.

   C. Install Phase Sequence Relay.

      (1) Place relay in position and install mounting screws.

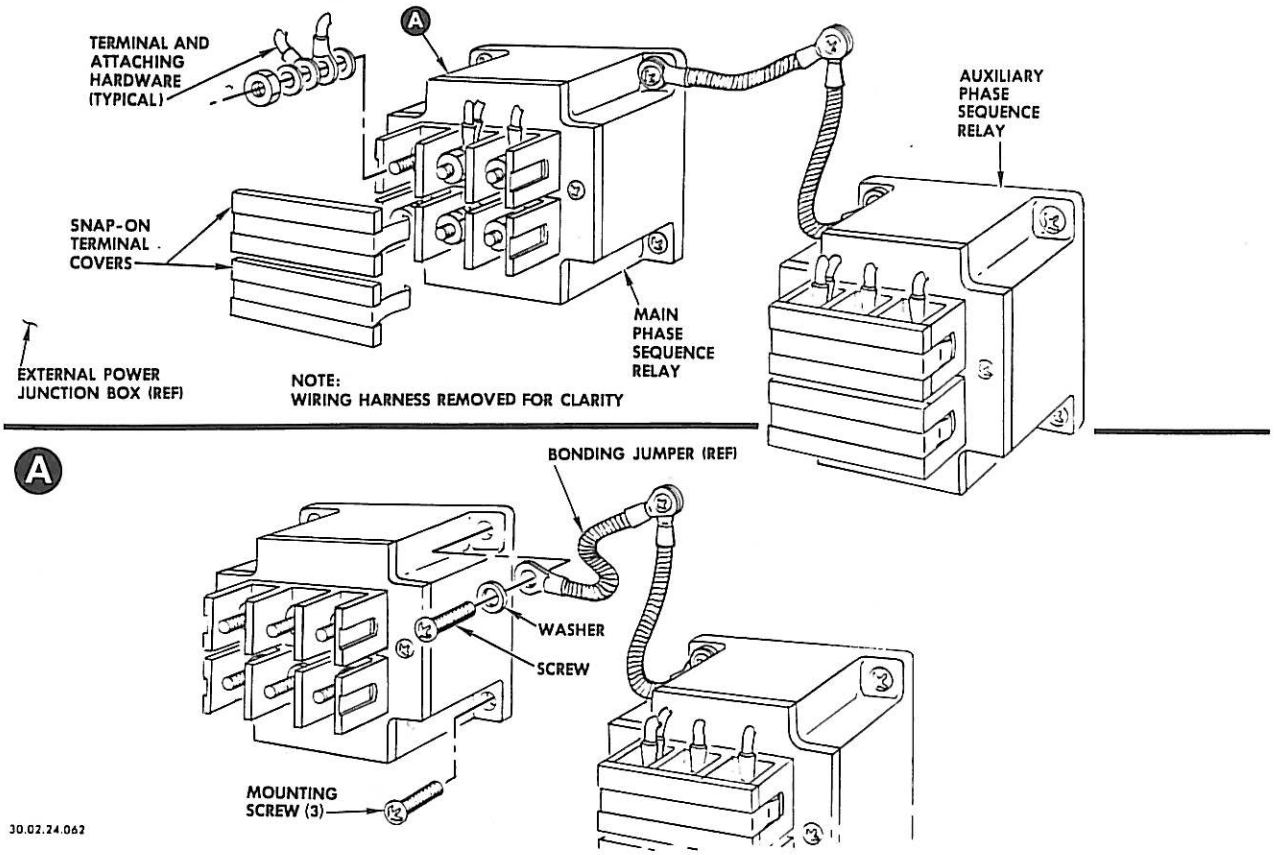
      NOTE: Make sure bonding jumper is placed under the head of proper mounting screw.

      (2) Replace wires on terminal studs.

      (3) Replace terminal stud cover.

      (4) Energize the external ac power system.

      (5) Test system operation (refer to Section 24-3-0, Adjustment/Test).


TERMINAL AND ATTACHING HARDWARE (TYPICAL)
A
AUXILIARY PHASE SEQUENCE RELAY
SNAP-ON TERMINAL COVERS
MAIN PHASE SEQUENCE RELAY
EXTERNAL POWER JUNCTION BOX (REF)
NOTE:
WIRING HARNESS REMOVED FOR CLARITY
A
BONDING JUMPER (REF)
WASHER
SCREW
MOUNTING SCREW (3)
30.02.24.062

EXTERNAL POWER T-R UNIT - MAINTENANCE PRACTICES

1. Removal/Installation External Power T-R Unit (see Figure 201)

   A. Equipment Required - None.

   B. Remove External Power T-R Unit.

      (1) Check that an external power unit is not connected to the airplane's external power receptacles.

      (2) Remove safety wire from electrical connector and knurled retaining nut. Loosen retaining nut so that it falls free from unit retaining bracket. Remove electrical connector.

      (3) Remove screw securing bonding strap to unit and remove unit.

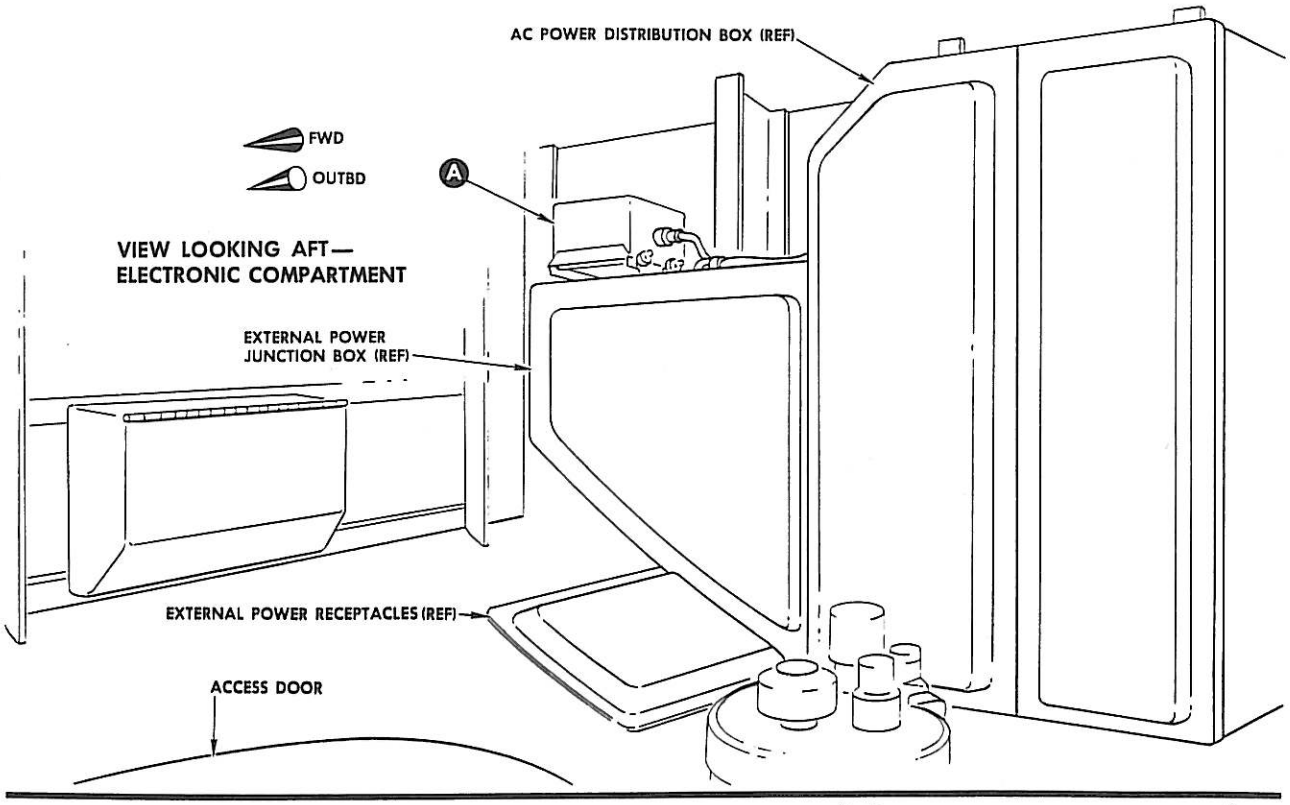
   C. Install External Power T-R Unit.

      (1) Place unit in position on top of external power junction box and secure with knurled retaining nut.

      (2) Replace bonding strap with screw removed in Step B 3.

      (3) Replace electrical connector. Safety-wire electrical connector and knurled retaining nut.

      (4) Test system operation (refer to Section 24-3-0, Adjustment/Test).


AC POWER DISTRIBUTION BOX (REF)
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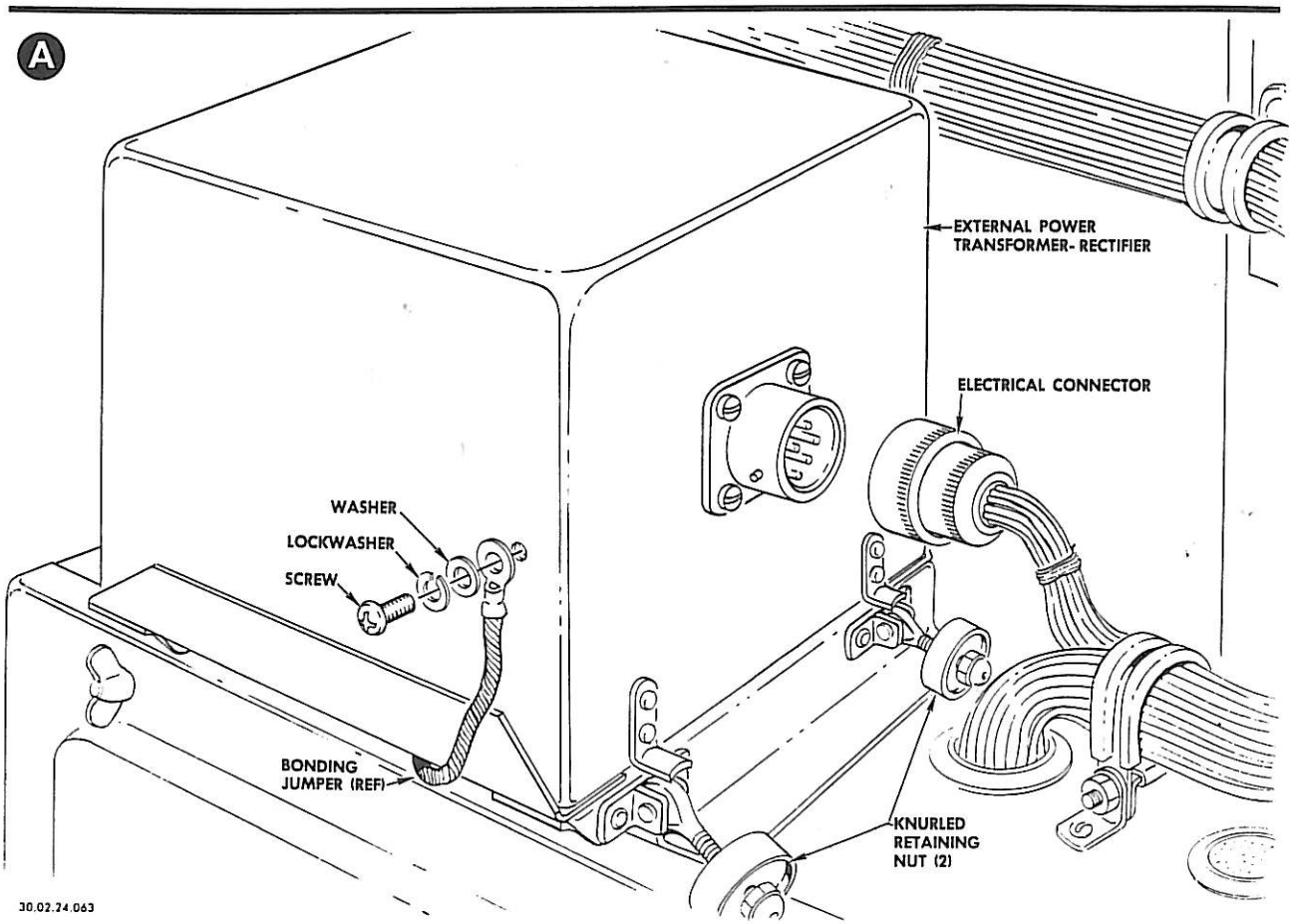
EXTERNAL POWER
JUNCTION BOX (REF)
EXTERNAL POWER RECEPTACLES (REF)
ACCESS DOOR


A
EXTERNAL POWER
TRANSFORMER- RECTIFIER
ELECTRICAL CONNECTOR
WASHER
LOCKWASHER
SCREW
BONDING
JUMPER (REF)
KNURLED
RETAINING
NUT (2)
30.02.24.063

AC SYSTEM EMERGENCY OPERATION - DESCRIPTION AND OPERATION

1. Description

The ac power supply system normally uses four generators to carry all normal airplane electrical loads, plus 100 percent standby. However, with the loss of one or more generators, operation continues as follows:

Number of Generators Operating	Load Limits
3	All Normal Loads
2	All Essential Loads
1	All Emergency Loads

NOTE: The following section covers an operation with only one generator.

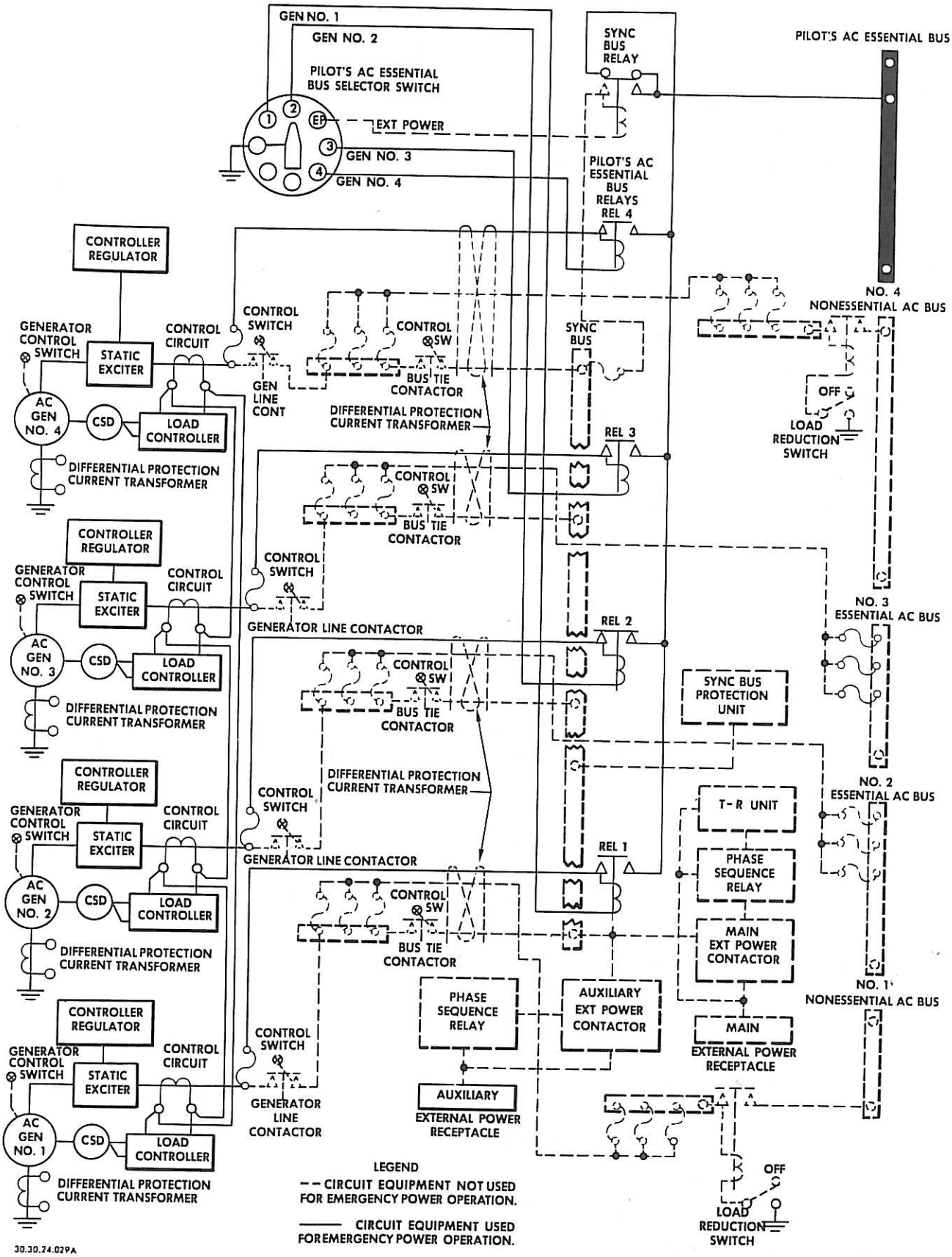
The only load bus energized during an ac system emergency operation is the pilots' ac essential bus (see Figure 1). During this operation only a select number of circuits essential to the safe flight of the airplane are powered. The pilots' ac essential bus selector switch controls the flow of the operating generator's output to the bus by actuating a relay connecting the generator output to the bus. The pilots' ac essential bus selector switch mounts on the overhead switch panel and the relays are located in the external power junction box in the electrical compartment.

2. Operation

The pilots' ac essential bus selector switch permits the pilots' optional selection of any operating generator to supply ac power to fly the airplane under adverse conditions. When the selector switch is placed in any generator position (GEN No. 1, GEN No. 2, GEN No. 3, or GEN No. 4) an associated relay closes, connecting the selected generator's output to the pilots' ac essential bus. The relay contacts are the only controlling element for power between the generator and the bus. If for instance, the No. 1 generator was the only one operating, the pilot would position the selector switch in the GEN No. 1 position. This switch action completes the ground circuit for the No. 1 relay and all circuits connected to the pilots' bus would be operable. This procedure is common to any generator operating during an emergency, one generator operation. The procedure allows only one generator to be connected to the pilots ac essential bus at one time. During an emergency operation, all generator line and bus tie contactor controls switches should be placed in the OPEN position to prevent power being supplied to any other load bus.

3. Pilots' AC Essential Bus Relays

There are two pilot ac essential bus relay units in the system. The relays are located in the external power junction box in the electrical compartment. Each unit contains two relays for control of the generator output to the pilots' ac essential bus. The relays enable the pilots to select any



Emergency Operation of the AC System
Figure 1

operating generator to supply power to their essential bus if a malfunction disables the parallel system. Selection of a generator is possible by rotating the control knob on the pilots' essential bus selector switch to the GEN No. 1, 2, 3, or 4 position. This action will actuate the selected relay and power will be available on the bus. Control coil power for each relay is obtained from the related generator to assure operation.

A sync bus relay is provided in the ac system. This relay is located in the dc power and emergency bus box under the main circuit breaker panel. The sync bus relay routes power from the sync bus to the pilots' ac essential bus when the ac system is energized by an external ac power unit. The sync bus relay is actuated by placing the pilots' ac essential bus selector switch in the EXT PWR position.

AC SYSTEM EMERGENCY OPERATION - MAINTENANCE PRACTICES

1. Adjustment/Test AC System Emergency Operation

A. General.

To test the ac system for emergency operation it is necessary to have all engines operating, and all ac generator systems connected to their respective load buses. The external ac power system should be operating and connected to the sync bus.

B. Equipment Required - External ac power unit.

C. Preparation.

(1) Check the following ac system control switches for the configuration indicated.

(a) External power control switch - ON.

(b) Generator control switches - ON.

(c) Generator line switch - CLOSE.

(d) Bus tie control switches - CLOSE.

(e) Generator disconnect switches - NORMAL.

(f) Load reduction switches - ON.

(g) 26-volt ac power selector switch - MAIN.

(h) Battery control switch - OFF.

(i) T-R control switches - ON.

(j) Pilots' ac essential bus selector switch - EXT PWR.

(2) Check that the following circuit breakers are closed:

(a) GENERATOR AC POWER CONT 1, 2, 3, and 4.

(b) KW/KVAR SEL.

(c) GENERATOR AC SYS IND LTS - 2, 3, 1 and 4.

(d) BAT CHGR REL CONT.

(e) INST AC PWR FAIL LTS.

(f) 26V AC INST BUS CONT

(g) CSD WARN 1, 2, 3, and 4.

(h) CSD CONTROL 1, 2, 3, and 4.

(i) MASTER WARN CONT & A.P. OFF.

(j) MASTER WARN.

(3) Check the following ac system warning lights for the configurations indicated:

(a) Load reduction bus 1 and 4 OFF lights - extinguished.

(b) DRIVE MALFUNC lights - extinguished.

(c) External power CONN and ON lights (2 each) - illuminated.

(d) Bus tie CONT OPEN lights - illuminated.

(e) Generator line CONT OPEN lights - extinguished.

(f) Generator OFF lights - extinguished.

(g) Generator OVERHEAT light - extinguished.

(h) ESSENTIAL BUS FAIL light - extinguished.

(i) INSTR PWR FAIL light - extinguished.

(j) 28-volt dc essential bus OFF light - extinguished.

(k) 29-volt dc emergency bus OFF light - extinguished.

(l) Battery charger RELAY OPEN light - extinguished.

D. Test AC System Emergency Operation.

(1) Energize the external ac power system (refer to Section 24-3-0, Adjustment/Test).

(2) Start all engines (refer to Chapter 71, POWER PLANT - GENERAL).

(3) Turn pilots' ac essential bus selector switch to GEN 1 position. Essential bus fail light shall remain extinguished.

(4) Turn generator No. 1 control switch to OFF.

(a) The generator No. 1 OFF light shall illuminate.

(b) The ESSENTIAL BUS FAIL light shall illuminate.

(5) Turn Generator No. 1 control switch to ON.

(a) The generator No. 1 OFF light shall extinguish.

(b) The ESSENTIAL BUS FAIL light shall extinguish.

(6) Repeat the preceding steps, (3) through (5), for each generator position. Results shall be the same for each.

(7) Place all switches in position indicated under Preparation step (1).

(8) Shut down engines and remove external power.

PILOTS' AC ESSENTIAL BUS RELAYS - MAINTENANCE PRACTICES

1. Removal/Installation Pilots' AC Essential Bus Relays (see Figure 201)

   A. Equipment Required - None.

   B. Remove Pilots' Essential Bus Relays.

      (1) Check that all airplane power is removed.

      (2) Remove two screws securing plastic guard over relay terminals.

      (3) Remove all wires from relay terminals.

      (4) Remove mounting screws.

      NOTE: Identify mounting screw that secures bonding jumper.

   C. Install Pilots' Essential Bus Relay.

      (1) Place relay in proper position and install mounting screws.

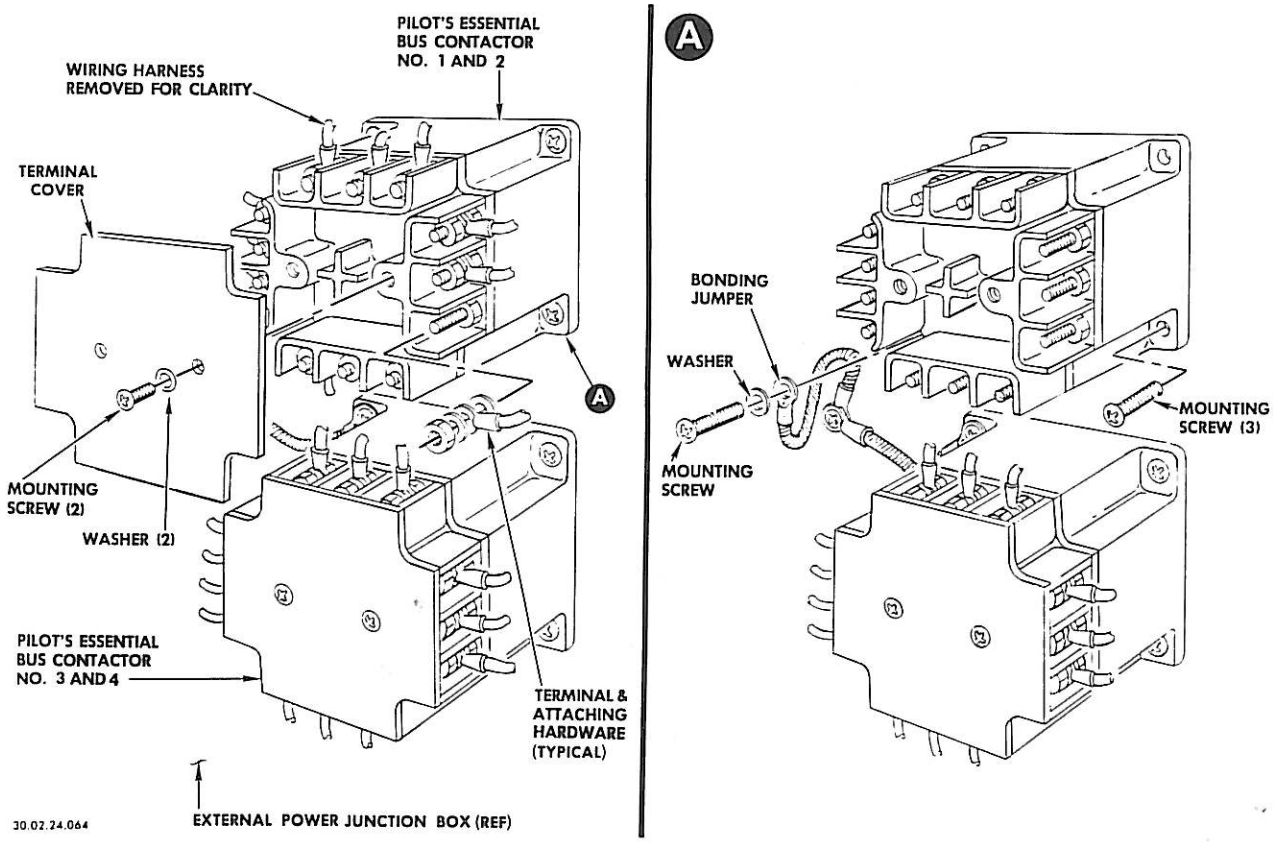
      NOTE: Be sure to place bonding jumper under proper mounting screw.

      (2) Attach all wires.

      (3) Place plastic guard over terminal studs and install two mounting screws.

      (4) Turn on external ac power system.

      (5) Test system operation (refer to Section 24-4-0, Adjustment/Test).



Pilots' Essential Bus Relay Installation
Figure 201

DC POWER SUPPLY SYSTEM - DESCRIPTION AND OPERATION

1. Description

The normal dc power system (see Figure 1) consists of transformer-rectifier units, reverse current relays, an essential bus disconnect relay, warning lights, control switches, instruments, and interconnecting circuitry. During normal operations, the 28-volt dc emergency bus and the 28-volt dc essential bus are energized whenever the ac generators are operating and the ac load buses are energized. When the dc buses are energized, all dc circuits are operable. Control switches for the system are located on the flight engineer's control panel near the system meters, as shown in Figure 2, and all other system components are located in the electrical compartment.

There is a warning light included in the normal dc power system to indicate when the 28-volt dc essential bus is deenergized and one to indicate when the 28-volt dc emergency bus is deenergized. These lights incorporate a press-to-test feature that is energized by depressing the bezel covering the bulb. When power is on and the bezel is depressed, the light should illuminate to indicate that the bulb is good.

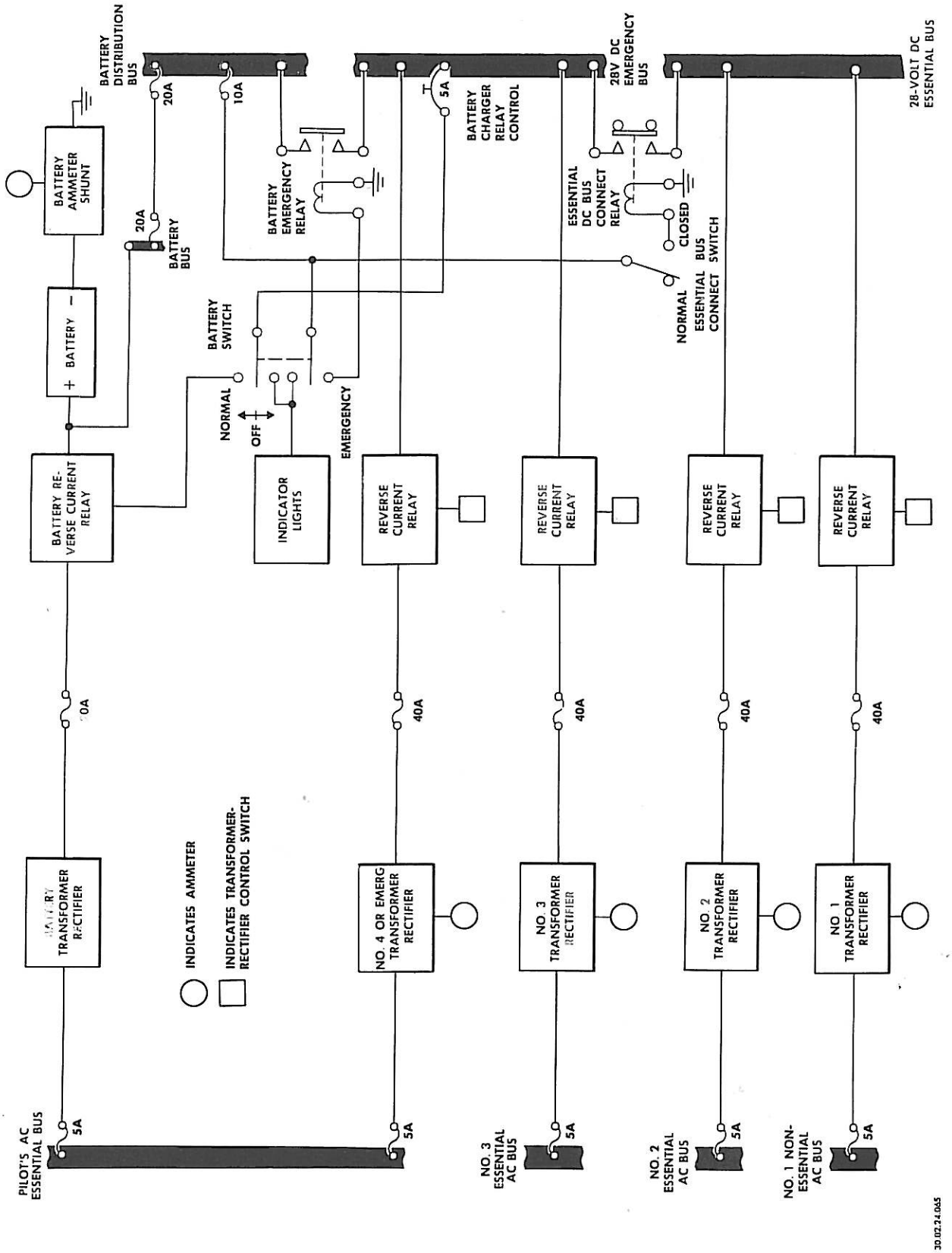
The normal dc system includes five control switches; a manual OFF-ON switch for each of the four T-R units and a battery switch that either energizes the circuitry for battery charging or for battery power, and at the same time routes power for the operation and testing of the warning indication lights.

2. System Operation

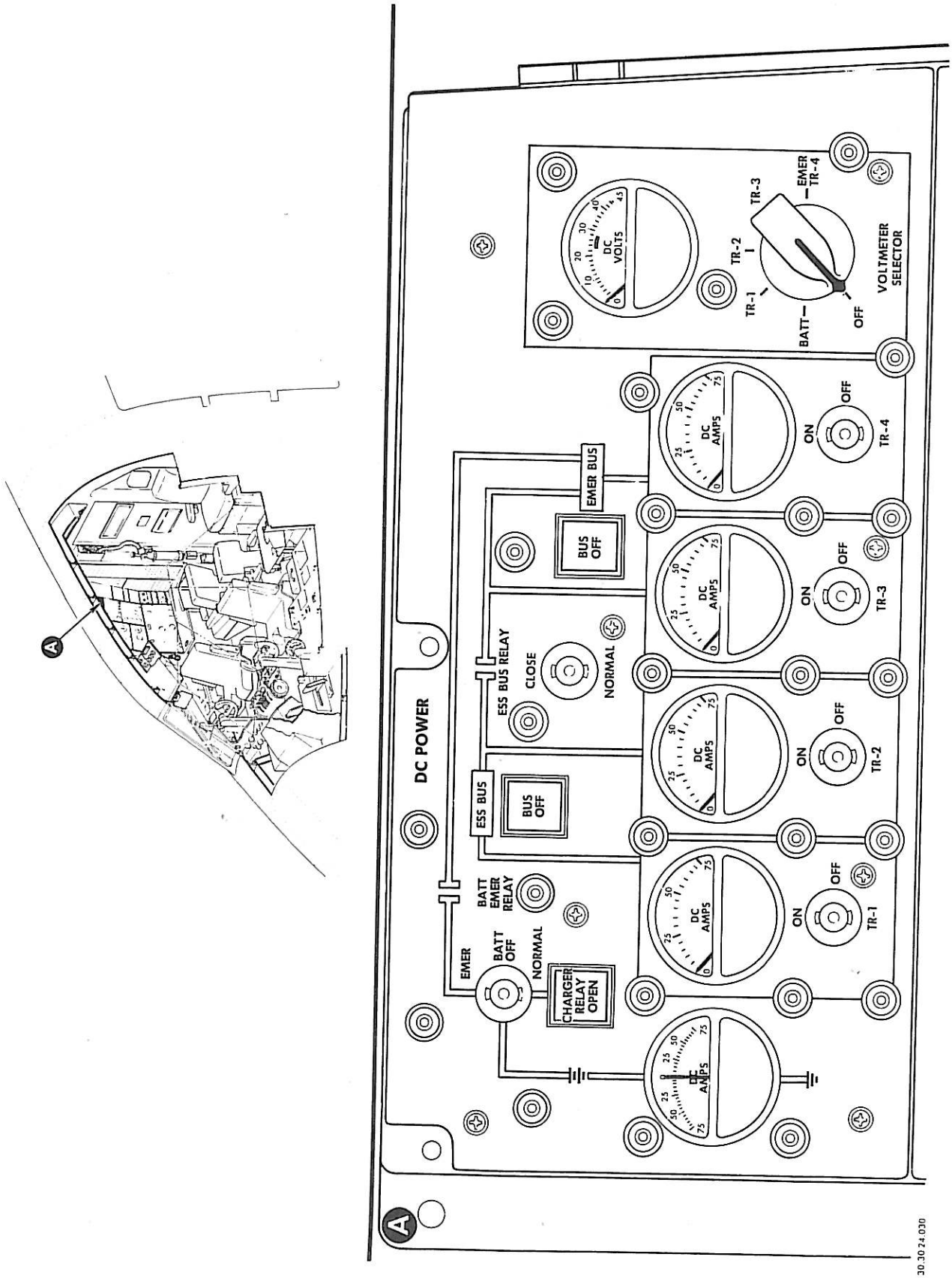
NOTE: The ac power system must be operating for the normal dc power system to be operative. This procedure is covered in Section 24-2-0, NORMAL AC POWER SYSTEM. Throughout the following section, the assumption will be that the ac power system is energized to avoid repetition.

Normal operation of the dc system is completely automatic, either on or off, when the ac system is energized and/or deenergized. Control switches are included in the system for the battery circuit and to connect or disconnect the T-R units during a malfunction, or during emergencies.

The T-R units connect to the ac load buses through protective fuses, and the output of the T-R units is fused before it connects to the reverse current relays. A power lead from the input side of the reverse current relay routes through the T-R unit control switches and back to the actuating coil of the reverse current relay. When these switches are ON the relays close because of the voltage differential. The T-R units are now connected to the 28-volt dc emergency and essential buses. Power is available for all dc circuits connected to the buses.



DC Power System Diagram
Figure 1



Flight Engineer's DC Control Panel
Figure 2

When the pil ts' ac essentıal bus is energized and the battery switch is in the NORMAL posıtion, the battery reverse current relay closes allowıng the battery T-R unıt to charge the 2 .5 volt battery. Any dc power T-R unit can be disconnected from the dc buses by the T-R (ON-OFF) control switches on the flıght engıneer's dc control panel.

A voltmeter and a voltmeter selector switch enable the flight engineer to monitor the voltage of the T-R units or the battery. Ammeters are provided for each T-R unit output and for the battery output circuit.

3. DC Distributıon

The power for distribution (see Figure 3) to the airplane dc circuits is divided into two categories, essential and emergency. The No. 1 and 2 T-R unit outputs connect directly to the 28-volt dc essential bus and the No. 3 and 4 T-R unıt outputs to the 28-volt dc emergency bus. Normally, these buses are isolated from each other, however, if it becomes necessary to connect them together the ESS BUS RELAY, NORMAL - CLOSE, switch should be moved to CLOSE. This energizes the essentıal bus connect relay, connecting the buses together. In the NORMAL position the relay contacts are open and the buses are ısolated from each other.

Main bus feeder lines route power to the individual circuits. Feeder lines are fused at the main buses and the opposite ends generally route to a small bus to which the circuit breakers for individual circuit power connect.

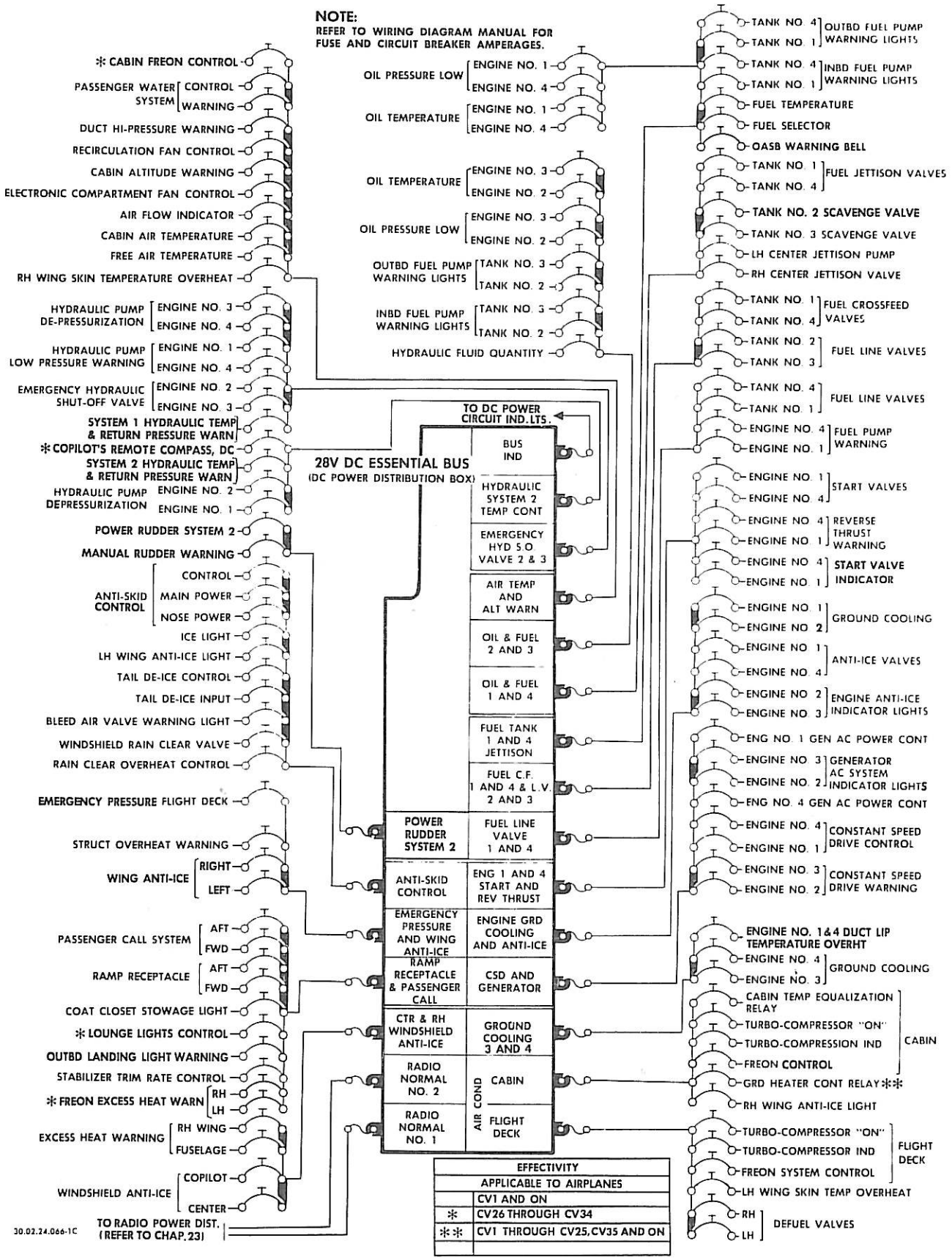
4. Transformer-Rectifier Unıts (see Figure 4)

The dc power system incorporates six ac-powered, transformer-rectifier units to supply the required current to energize the distribution buses and provide charging current for the battery. (One T-R unit is incorporated in the external ac system and is described in Section 24-3-0.) The following list indicates the T-R unit number or name, the ac bus from which it is supplied operating power, and the dc bus to which its output connects:

T-R UNIT	AC INPUT SUPPLY BUS	POWER TO
No. 1 (50-Ampere)	No. 1 Nonessential AC Bus	DC Essential Bus
No. 2 (50-Ampere)	No. 2 Essential AC Bus	DC Essential Bus
No. 3 (50-Ampere)	No. 3 Essential AC Bus	DC Emergency Bus
No. 4 (50-Ampere) "Emergency"	Pilots' AC Essential Bus	DC Emergency Bus
Battery (20-Ampere)	Pilots' AC Essential Bus	Battery

The first four units listed above consist of a 3-phase transformer, numerous rectifiers, and a shunt for the metering circuit. The battery T-R unit consists of a 3-phase transformer and numerous rectifers but the metering circuit connects to a separate shunt.

During operation, ac power routes to the T-R units, and the T-R output routes to the reverse current relay which, because of the voltage differential, closes and connects the output of the T-R unit to the essential



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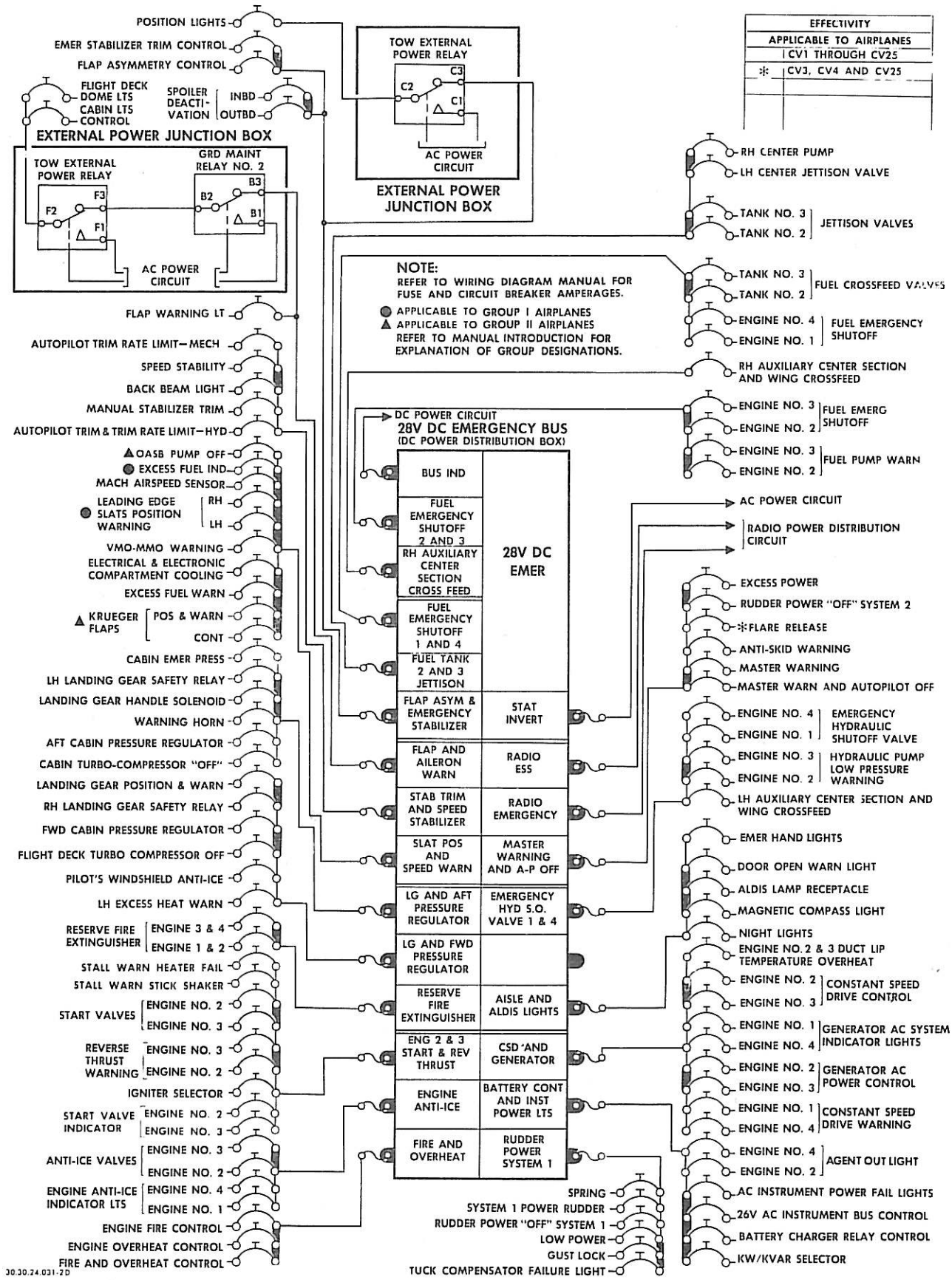
DC Power Distribution System
Figure 3 (Sheet 1 of 4)


EFFECTIVITY
APPLICABLE TO AIRPLANES
CV1 THROUGH CV25
* CV3, CV4 AND CV25
POSITION LIGHTS
EMER STABILIZER TRIM CONTROL
FLAP ASYMMETRY CONTROL
FLIGHT DECK DOME LTS
CABIN LTS CONTROL
SPOILER DEACTI-VATION
INBD
OUTBD
EXTERNAL POWER JUNCTION BOX
TOW EXTERNAL POWER RELAY
GRD MAINT RELAY NO. 2
AC POWER CIRCUIT
TOW EXTERNAL POWER RELAY
AC POWER CIRCUIT
EXTERNAL POWER JUNCTION BOX
NOTE:
REFER TO WIRING DIAGRAM MANUAL FOR FUSE AND CIRCUIT BREAKER AMPERAGES.
● APPLICABLE TO GROUP I AIRPLANES
▲ APPLICABLE TO GROUP II AIRPLANES
REFER TO MANUAL INTRODUCTION FOR EXPLANATION OF GROUP DESIGNATIONS.
FLAP WARNING LT
AUTOPILOT TRIM RATE LIMIT—MECH
SPEED STABILITY
BACK BEAM LIGHT
MANUAL STABILIZER TRIM
AUTOPILOT TRIM & TRIM RATE LIMIT—HYD
▲ OASB PUMP OFF
● EXCESS FUEL IND
MACH AIRSPEED SENSOR
● LEADING EDGE SLATS POSITION WARNING
RH
LH
VMO-MMO WARNING
ELECTRICAL & ELECTRONIC COMPARTMENT COOLING
EXCESS FUEL WARN
▲ KRUEGER FLAPS
POS & WARN
CONT
CABIN EMER PRESS
LH LANDING GEAR SAFETY RELAY
LANDING GEAR HANDLE SOLENOID
WARNING HORN
AFT CABIN PRESSURE REGULATOR
CABIN TURBO-COMPRESSOR "OFF"
LANDING GEAR POSITION & WARN
RH LANDING GEAR SAFETY RELAY
FWD CABIN PRESSURE REGULATOR
FLIGHT DECK TURBO COMPRESSOR OFF
PILOT'S WINDSHIELD ANTI-ICE
LH EXCESS HEAT WARN
RESERVE FIRE EXTINGUISHER
ENGINE 3 & 4
ENGINE 1 & 2
STALL WARN HEATER FAIL
STALL WARN STICK SHAKER
START VALVES
ENGINE NO. 2
ENGINE NO. 3
REVERSE THRUST WARNING
ENGINE NO. 3
ENGINE NO. 2
IGNITER SELECTOR
START VALVE INDICATOR
ENGINE NO. 2
ENGINE NO. 3
ANTI-ICE VALVES
ENGINE NO. 3
ENGINE NO. 2
ENGINE ANTI-ICE INDICATOR LTS
ENGINE NO. 4
ENGINE NO. 1
ENGINE FIRE CONTROL
ENGINE OVERHEAT CONTROL
FIRE AND OVERHEAT CONTROL
DC POWER CIRCUIT
28V DC EMERGENCY BUS
(DC POWER DISTRIBUTION BOX)
BUS IND
FUEL EMERGENCY SHUTOFF 2 AND 3
RH AUXILIARY CENTER SECTION CROSS FEED
FUEL EMERGENCY SHUTOFF 1 AND 4
FUEL TANK 2 AND 3 JETTISON
FLAP ASYM & EMERGENCY STABILIZER
FLAP AND AILERON WARN
STAB TRIM AND SPEED STABILIZER
SLAT POS AND SPEED WARN
LG AND AFT PRESSURE REGULATOR
LG AND FWD PRESSURE REGULATOR
RESERVE FIRE EXTINGUISHER
ENG 2 & 3 START & REV THRUST
ENGINE ANTI-ICE
FIRE AND OVERHEAT
28V DC EMER
STAT INVERT
RADIO ESS
RADIO EMERGENCY
MASTER WARNING AND A-P OFF
EMERGENCY HYD S.O. VALVE 1 & 4
AISLE AND ALDIS LIGHTS
CSD AND GENERATOR
BATTERY CONT AND INST POWER LTS
RUDDER POWER SYSTEM 1
SPRING
SYSTEM 1 POWER RUDDER
RUDDER POWER "OFF" SYSTEM 1
LOW POWER
GUST LOCK
TUCK COMPENSATOR FAILURE LIGHT
RH CENTER PUMP
LH CENTER JETTISON VALVE
TANK NO. 3
TANK NO. 2
JETTISON VALVES
TANK NO. 3
TANK NO. 2
FUEL CROSSFEED VALVES
ENGINE NO. 4
ENGINE NO. 1
FUEL EMERGENCY SHUTOFF
RH AUXILIARY CENTER SECTION AND WING CROSSFEED
ENGINE NO. 3
ENGINE NO. 2
FUEL EMERG SHUTOFF
ENGINE NO. 3
ENGINE NO. 2
FUEL PUMP WARN
AC POWER CIRCUIT
RADIO POWER DISTRIBUTION CIRCUIT
EXCESS POWER
RUDDER POWER "OFF" SYSTEM 2
* FLARE RELEASE
ANTI-SKID WARNING
MASTER WARNING
MASTER WARN AND AUTOPILOT OFF
ENGINE NO. 4
ENGINE NO. 1
EMERGENCY HYDRAULIC SHUTOFF VALVE
ENGINE NO. 3
ENGINE NO. 2
HYDRAULIC PUMP LOW PRESSURE WARNING
LH AUXILIARY CENTER SECTION AND WING CROSSFEED
EMER HAND LIGHTS
DOOR OPEN WARN LIGHT
ALDIS LAMP RECEPTACLE
MAGNETIC COMPASS LIGHT
NIGHT LIGHTS
ENGINE NO. 2 & 3 DUCT LIP TEMPERATURE OVERHEAT
ENGINE NO. 2
ENGINE NO. 3
CONSTANT SPEED DRIVE CONTROL
ENGINE NO. 1
ENGINE NO. 4
GENERATOR AC SYSTEM INDICATOR LIGHTS
ENGINE NO. 2
ENGINE NO. 3
GENERATOR AC POWER CONTROL
ENGINE NO. 1
ENGINE NO. 4
CONSTANT SPEED DRIVE WARNING
ENGINE NO. 4
ENGINE NO. 2
AGENT OUT LIGHT
AC INSTRUMENT POWER FAIL LIGHTS
26V AC INSTRUMENT BUS CONTROL
BATTERY CHARGER RELAY CONTROL
KW/KVAR SELECTOR
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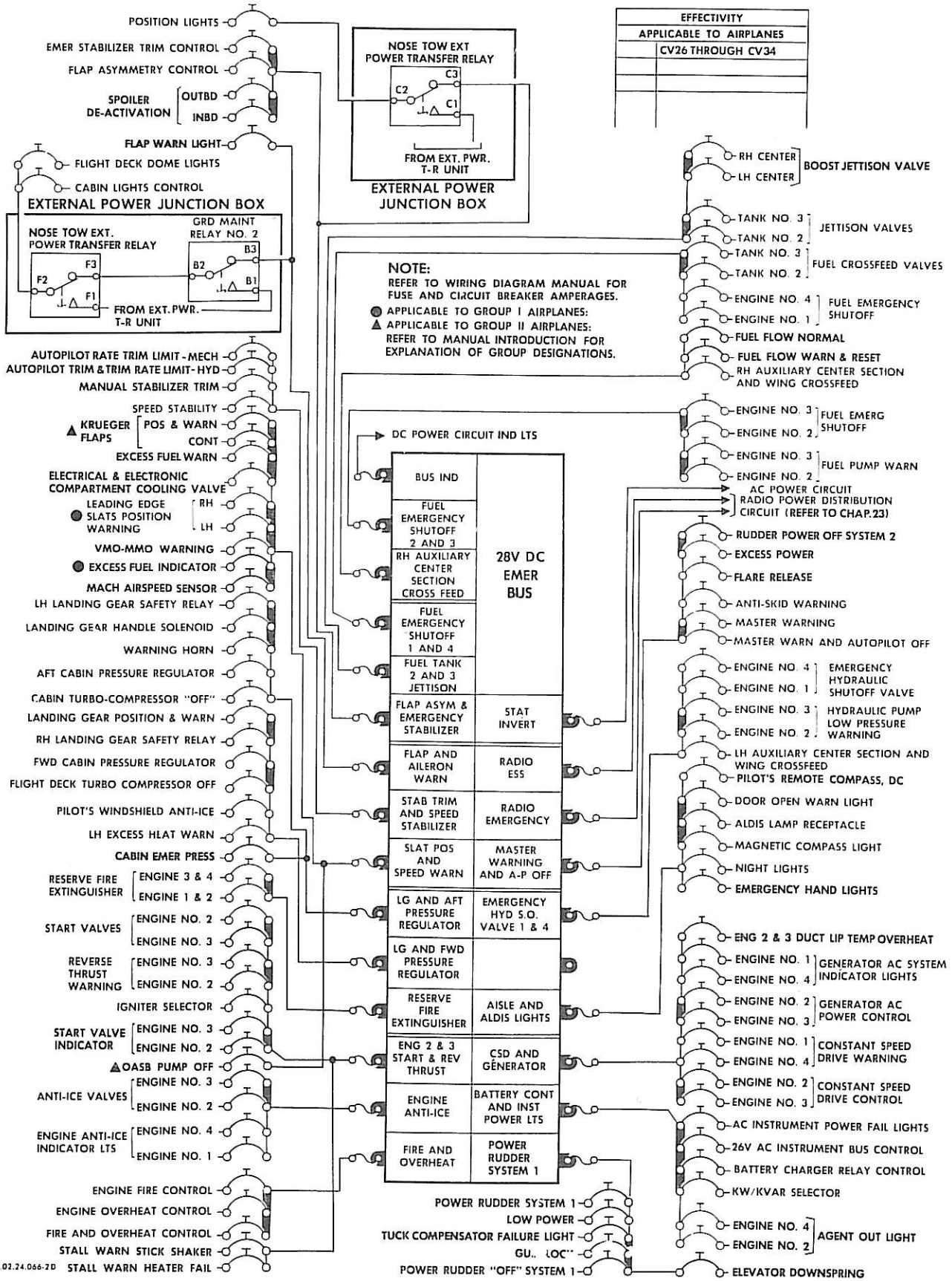
EFFECTIVITY
APPLICABLE TO AIRPLANES
CV26 THROUGH CV34
NOSE TOW EXT POWER TRANSFER RELAY
C3
C2
C1
FROM EXT. PWR. T-R UNIT
EXTERNAL POWER JUNCTION BOX
EXTERNAL POWER JUNCTION BOX
NOSE TOW EXT. POWER TRANSFER RELAY
GRD MAINT RELAY NO. 2
B3
B2
B1
F3
F2
F1
FROM EXT. PWR. T-R UNIT
NOTE:
REFER TO WIRING DIAGRAM MANUAL FOR FUSE AND CIRCUIT BREAKER AMPERAGES.
● APPLICABLE TO GROUP I AIRPLANES:
▲ APPLICABLE TO GROUP II AIRPLANES:
REFER TO MANUAL INTRODUCTION FOR EXPLANATION OF GROUP DESIGNATIONS.
DC POWER CIRCUIT IND LTS
28V DC EMER BUS
BUS IND
FUEL EMERGENCY SHUTOFF 2 AND 3
RH AUXILIARY CENTER SECTION CROSS FEED
FUEL EMERGENCY SHUTOFF 1 AND 4
FUEL TANK 2 AND 3 JETTISON
FLAP ASYM & EMERGENCY STABILIZER
STAT INVERT
FLAP AND AILERON WARN
RADIO ESS
STAB TRIM AND SPEED STABILIZER
RADIO EMERGENCY
SLAT POS AND SPEED WARN
MASTER WARNING AND A-P OFF
LG AND AFT PRESSURE REGULATOR
EMERGENCY HYD S.O. VALVE 1 & 4
LG AND FWD PRESSURE REGULATOR
RESERVE FIRE EXTINGUISHER
AISLE AND ALDIS LIGHTS
ENG 2 & 3 START & REV THRUST
CSD AND GENERATOR
ENGINE ANTI-ICE
BATTERY CONT AND INST POWER LTS
FIRE AND OVERHEAT
POWER RUDDER SYSTEM 1
POSITION LIGHTS
EMER STABILIZER TRIM CONTROL
FLAP ASYMMETRY CONTROL
SPOILER DE-ACTIVATION
OUTBD
INBD
FLAP WARN LIGHT
FLIGHT DECK DOME LIGHTS
CABIN LIGHTS CONTROL
AUTOPILOT RATE TRIM LIMIT - MECH
AUTOPILOT TRIM & TRIM RATE LIMIT - HYD
MANUAL STABILIZER TRIM
SPEED STABILITY
▲ KRUEGER FLAPS
POS & WARN
CONT
EXCESS FUEL WARN
ELECTRICAL & ELECTRONIC COMPARTMENT COOLING VALVE
● LEADING EDGE SLATS POSITION WARNING
RH
LH
VMO-MMO WARNING
● EXCESS FUEL INDICATOR
MACH AIRSPEED SENSOR
LH LANDING GEAR SAFETY RELAY
LANDING GEAR HANDLE SOLENOID
WARNING HORN
AFT CABIN PRESSURE REGULATOR
CABIN TURBO-COMPRESSOR "OFF"
LANDING GEAR POSITION & WARN
RH LANDING GEAR SAFETY RELAY
FWD CABIN PRESSURE REGULATOR
FLIGHT DECK TURBO COMPRESSOR OFF
PILOT'S WINDSHIELD ANTI-ICE
LH EXCESS HEAT WARN
CABIN EMER PRESS
RESERVE FIRE EXTINGUISHER
ENGINE 3 & 4
ENGINE 1 & 2
START VALVES
ENGINE NO. 2
ENGINE NO. 3
REVERSE THRUST WARNING
ENGINE NO. 3
ENGINE NO. 2
IGNITER SELECTOR
START VALVE INDICATOR
ENGINE NO. 3
ENGINE NO. 2
▲OASB PUMP OFF
ANTI-ICE VALVES
ENGINE NO. 3
ENGINE NO. 2
ENGINE ANTI-ICE INDICATOR LTS
ENGINE NO. 4
ENGINE NO. 1
ENGINE FIRE CONTROL
ENGINE OVERHEAT CONTROL
FIRE AND OVERHEAT CONTROL
STALL WARN STICK SHAKER
STALL WARN HEATER FAIL
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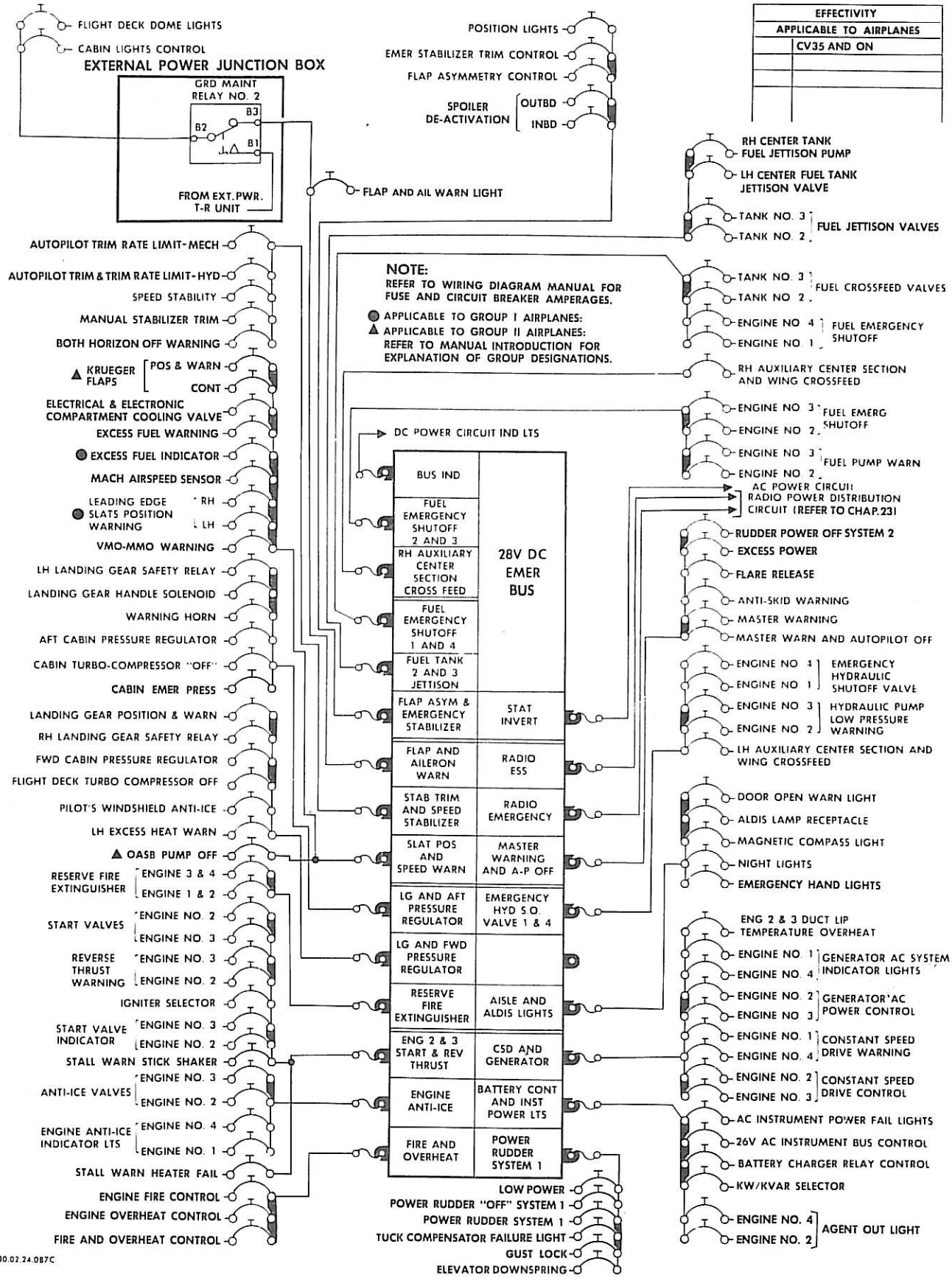
POWER RUDDER SYSTEM 1
LOW POWER
TUCK COMPENSATOR FAILURE LIGHT
GU.. LOC"
POWER RUDDER "OFF" SYSTEM 1
RH CENTER
LH CENTER
BOOST JETTISON VALVE
TANK NO. 3
TANK NO. 2
JETTISON VALVES
TANK NO. 3
TANK NO. 2
FUEL CROSSFEED VALVES
ENGINE NO. 4
ENGINE NO. 1
FUEL EMERGENCY SHUTOFF
FUEL FLOW NORMAL
FUEL FLOW WARN & RESET
RH AUXILIARY CENTER SECTION AND WING CROSSFEED
ENGINE NO. 3
ENGINE NO. 2
FUEL EMERG SHUTOFF
ENGINE NO. 3
ENGINE NO. 2
FUEL PUMP WARN
AC POWER CIRCUIT
RADIO POWER DISTRIBUTION CIRCUIT (REFER TO CHAP.23)
RUDDER POWER OFF SYSTEM 2
EXCESS POWER
FLARE RELEASE
ANTI-SKID WARNING
MASTER WARNING
MASTER WARN AND AUTOPILOT OFF
ENGINE NO. 4
ENGINE NO. 1
EMERGENCY HYDRAULIC SHUTOFF VALVE
ENGINE NO. 3
ENGINE NO. 2
HYDRAULIC PUMP LOW PRESSURE WARNING
LH AUXILIARY CENTER SECTION AND WING CROSSFEED
PILOT'S REMOTE COMPASS, DC
DOOR OPEN WARN LIGHT
ALDIS LAMP RECEPTACLE
MAGNETIC COMPASS LIGHT
NIGHT LIGHTS
EMERGENCY HAND LIGHTS
ENG 2 & 3 DUCT LIP TEMP OVERHEAT
ENGINE NO. 1
ENGINE NO. 4
GENERATOR AC SYSTEM INDICATOR LIGHTS
ENGINE NO. 2
ENGINE NO. 3
GENERATOR AC POWER CONTROL
ENGINE NO. 1
ENGINE NO. 4
CONSTANT SPEED DRIVE WARNING
ENGINE NO. 2
ENGINE NO. 3
CONSTANT SPEED DRIVE CONTROL
AC INSTRUMENT POWER FAIL LIGHTS
26V AC INSTRUMENT BUS CONTROL
BATTERY CHARGER RELAY CONTROL
KW/KVAR SELECTOR
ENGINE NO. 4
ENGINE NO. 2
AGENT OUT LIGHT
ELEVATOR DOWNSPRING

EFFECTIVITY
APPLICABLE TO AIRPLANES
CV35 AND ON



DC Power Distribution System
Figure 3 (Sheet 4 of 4)

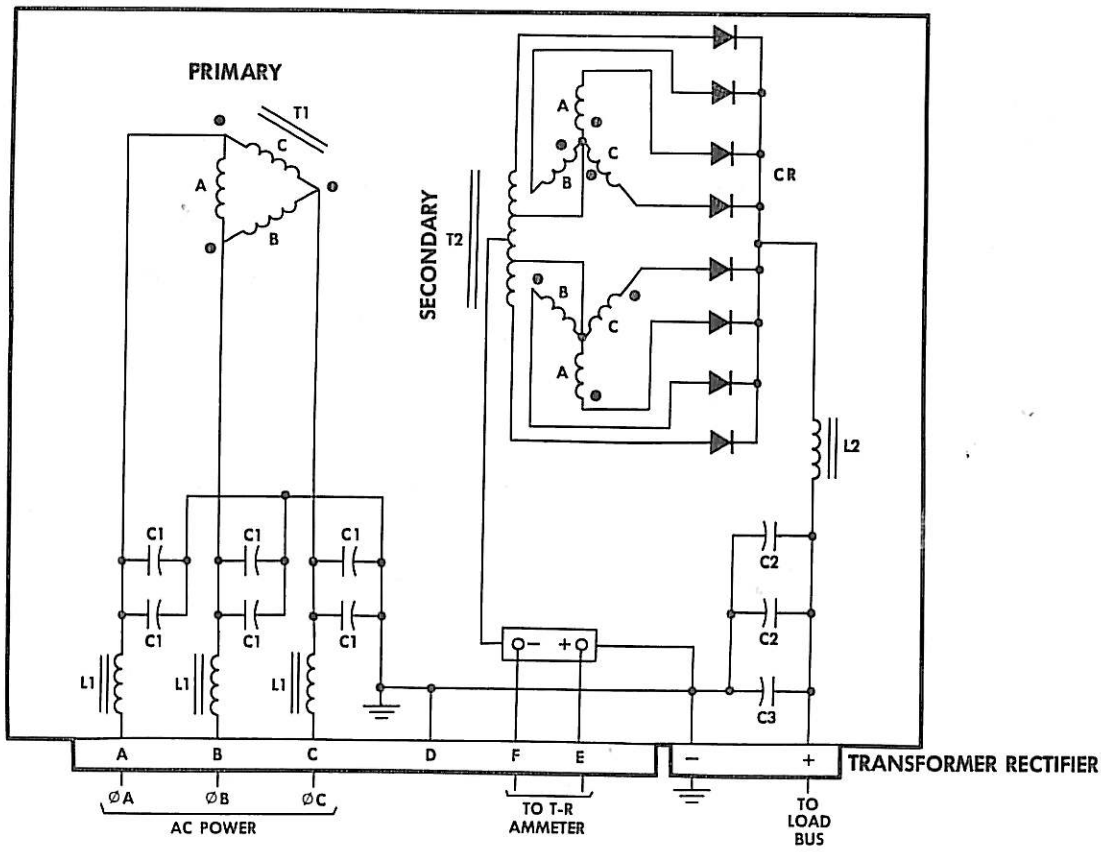
and emergency buses. Any T-R unit is isolated from the dc buses by placing the related c ntrol switch in the OFF position. This switch action opens contacts that remove the control power from the coil of the reverse current relay.

5. Reverse Current Relays (see Figure 5)

Th T-R units and the battery have a reverse urrent relay in their output circuit to control the bus-connecting operation. When dc power is routed from the T-R unit to the relay and through the control switch, the relay circuitry senses the difference between the bus voltage and the T-R unit output voltage and the relay contacts close, connecting dc power to the emergency and essential dc buses. The relay in the batter circuit functions to keep the battery on a floating charge during normal operations. The relays for the T-R units are located in the electrical compartment; the relay for the battery is installed near the battery and forward of the co-pilot's flight instrument panel.

6 Bus Off Light Relays (see Figure 6)

There are two bus off light relays in the dc system. One controls the amber ndicator light for the 28-volt dc essential bus and the other controls the amber indicator light for the 28-volt dc emergency bus. The relays consist of an actuating coil and numerous control contacts. Whenever the buses are energized, power routes to the contacts o the control coil, opening the normally closed contacts that provide a ground for the indicator light. If



T-R Unit Schematic Typical
Figure 4

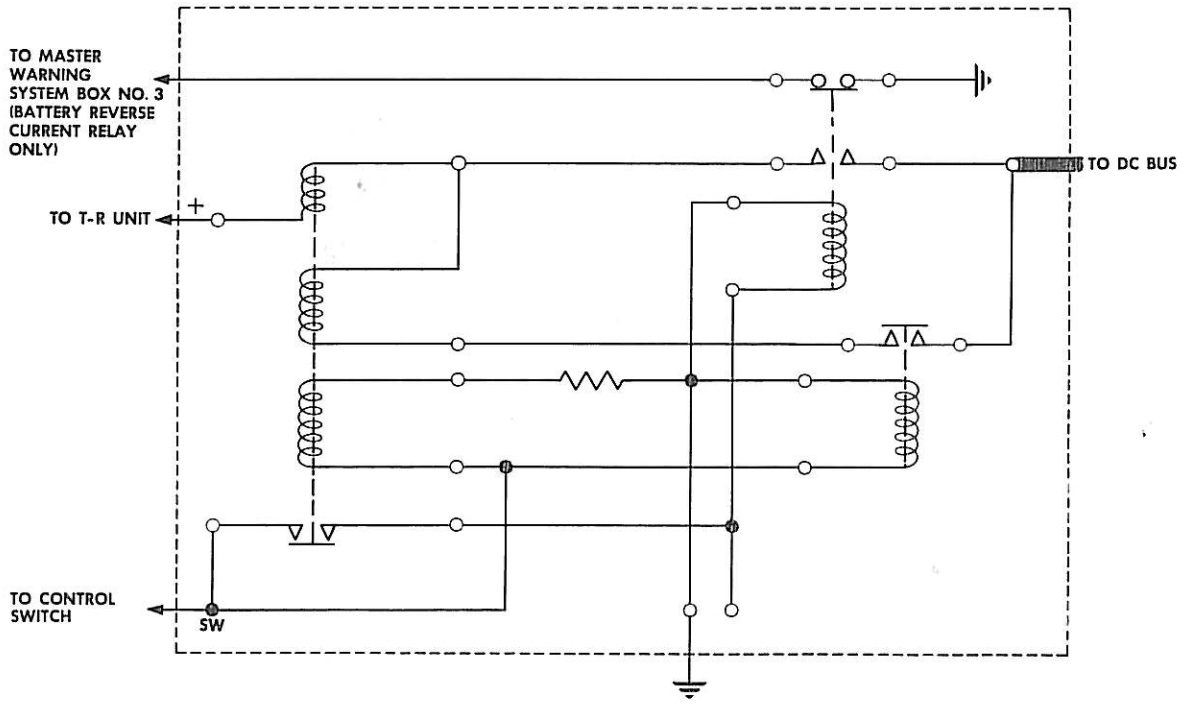
either or both buses are deenergized, the amber light or lights illuminate. These relays are located in the electrical compartment.

7. DC System Instruments (see Figure 7)

The dc system incorporates a voltmeter and five ammeters for visual indication of the line voltages and electrical loads in different parts of the system. The instruments and associated controls are located in the flight engineer's dc control panel.

A. DC Voltmeter Circuit.

The major components of the dc voltmeter circuit are a dc voltmeter and a rotary selector switch. The voltmeter dial is calibrated in 2-volt increments from 0 to 45 volts. The operating voltages between 27 and 29 are indicated by a green marker under the scale. Red markers are placed at the 19- and 35-volt indications. A voltage reading from the battery bus or from the output of any one of the four main T-R units is obtained by rotating the selector switch to the desired position. Selector switch positions are: OFF BAT, TR-1, TR-2, TR-3, and TR-4. Placing the selector switch in BATT or in any T-R position completes a circuit from the battery bus or the T-R unit output, through the selector switch, and through the voltmeter to ground.



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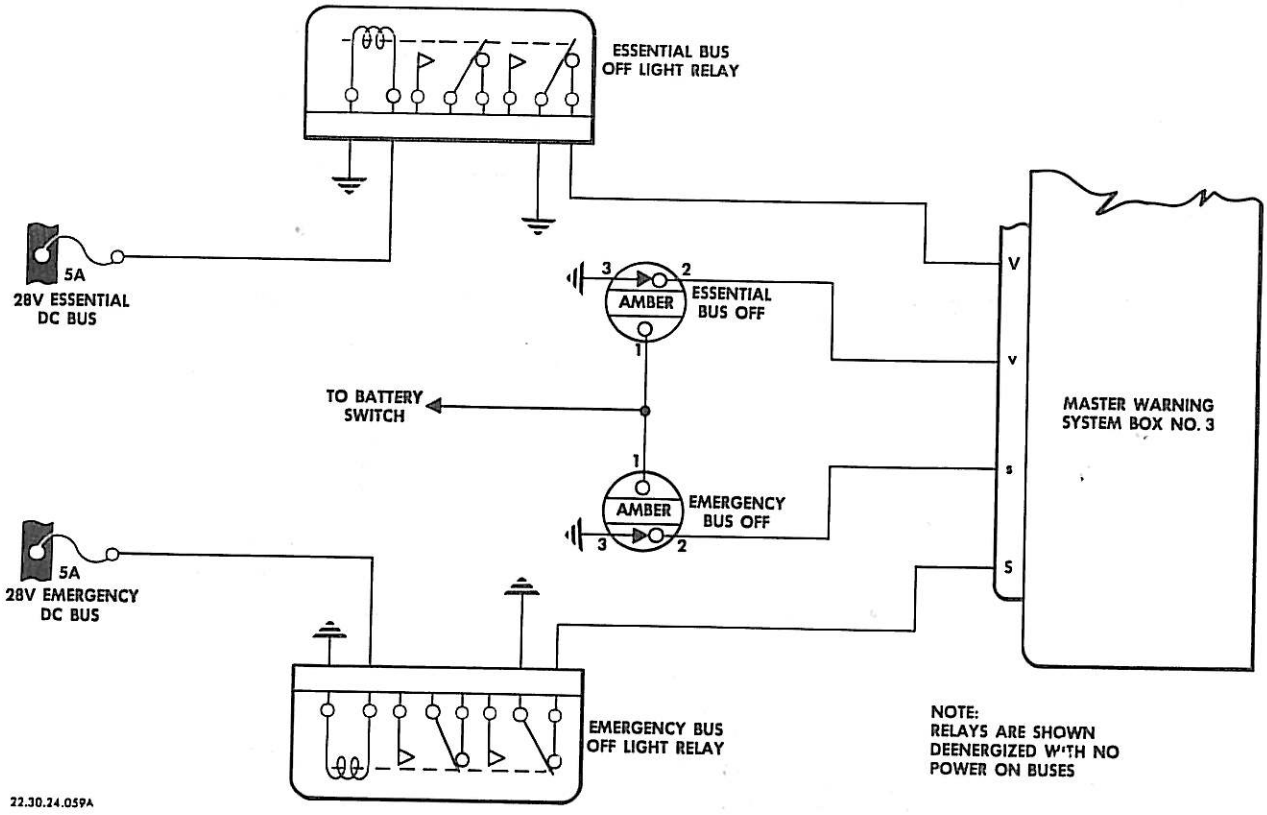
Reverse Current Relay Schematic
Figure 5

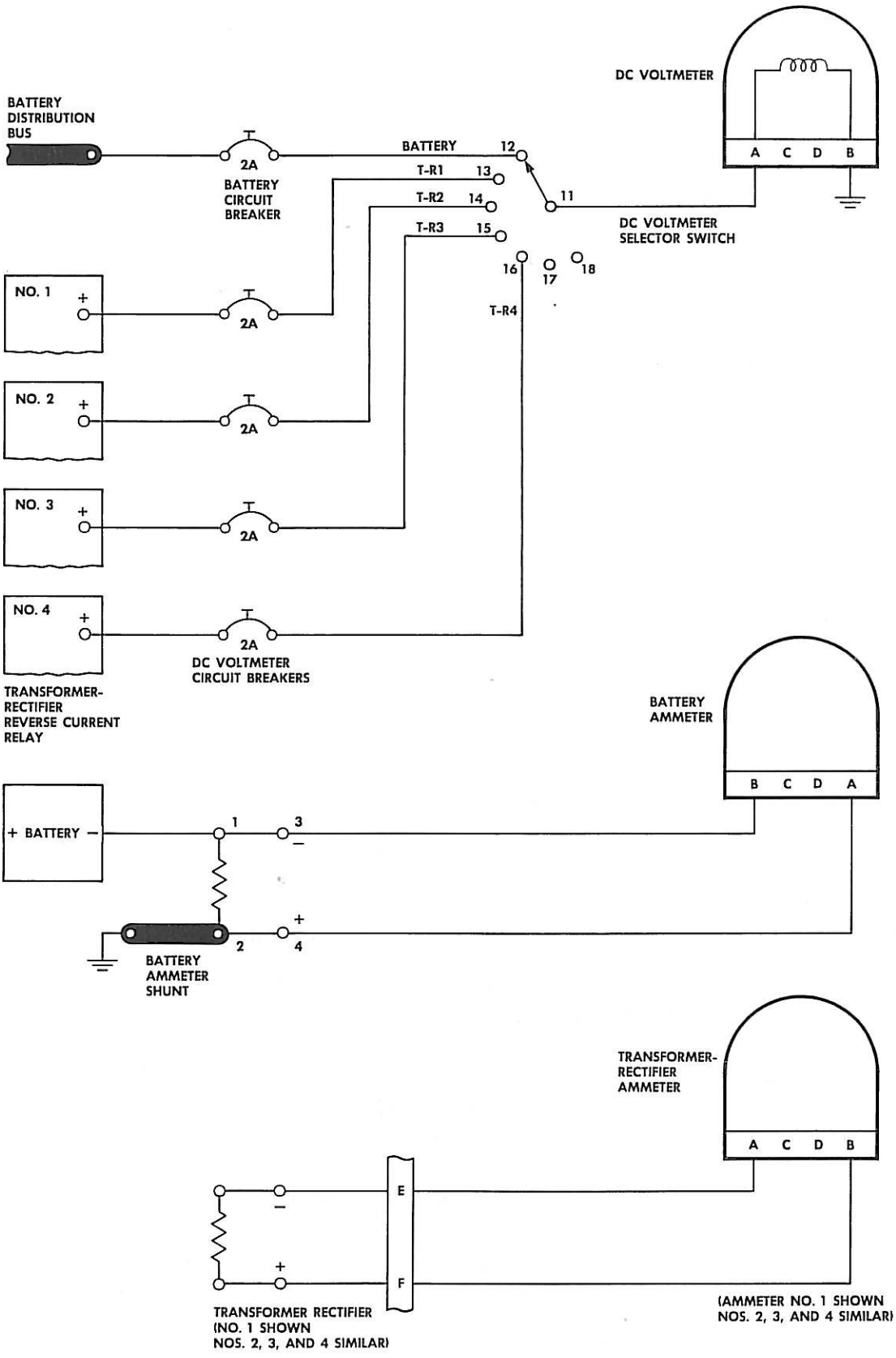
B. DC Ammeter Circuits.

The major components of each dc ammeter circuit are the ammeter and the shunt. The ammeter dials associated with the T-R units are calibrated in 5-ampere increments from 0 to 75 amperes with a red marker at the 50-ampere indication. The T-R unit ammeter circuit operates as long as the respective T-R unit is operating. The shunts for these circuits are located inside the T-R unit housings.

The battery ammeter dial has the zero reading in the center and is calibrated in 5-ampere increments from 0 to 75 amperes to the left and right. Readings to the left of zero indicate battery discharge rate and readings to the right of zero indicate battery charge rate. The battery ammeter shunt is located adjacent to the battery on the right side of the fuselage, forward of the copilot's instrument panel.



Bus Light OFF Relay Circuit
Figure 6



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DC Instrument Schematic
Figure 7

DC POWER SUPPLY SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. NO READING ON DC VOLTMETER WITH VOLTMETER SELECTOR SWITCH IN ONE OF THE T-R POSITIONS	
A. Improper or no input voltage at T-R unit connections.	Check for power at T-R plug. If no power check applicable distribution bus (refer to Section 24-2-0, AC Power Distribution).
B. Pilots' ac essential bus selector switch not in proper position (TR-4 only when operating with external power).	Check position of selector switch. If incorrect change to EXT PWR position.
C. Open limiter in circuit between T-R unit output and reverse current relay.	Check 40-ampere limiter(s) in dc distribution box. If open replace and check system operation.
D. Defective voltmeter.	Check all selector switch positions. If no indication replace voltmeter with one of known quality. Check system operation and send defective voltmeter to overhaul shop.
E. Defective airplane wiring.	Check voltmeter circuit wiring for continuity. If no continuity repair or replace wiring.
F. Defective T-R unit.	Check input and output voltage. If input voltage is good and no output voltage, replace T-R unit with one of known quality. Check system operation and send defective T-R unit to overhaul shop.
2. REVERSE CURRENT RELAY CONTACTS OPEN WITH T-R CONTROL SWITCH "ON"	
A. Open limiter in power circuit.	Check associated 5-ampere limiter in dc distribution box and 40-ampere limiter at T-R unit. If open replace limiter and check system operation.
B. Bus voltage higher than T-R unit output voltage.	Compare voltage readings of bus and T-R unit output. If T-R output voltage is too low, replace T-R unit with one of known quality and check system operation.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. REVERSE CURRENT RELAY CONTACTS OPEN WITH T-R CONTROL SWITCH "ON" (CONT)	
	If output voltage is normal, check remaining T-R units for excessive output voltages. Replace defective unit and check system operation.
C. Defective circuit wiring between reverse current relay coil and T-R control switch.	Check circuit continuity. If no continuity repair or replace wiring.
D. Defective T-R control switch.	Check continuity between switch terminals with switch on. If no continuity replace switch, check system operation.
E. Defective reverse current relay.	Replace relay with one of known quality, check operation. If operation is good, send defective unit to overhaul shop.
3. POWER ON EITHER ESSENTIAL OR EMERGENCY BUS AND ASSOCIATED BUS OFF LIGHT ILLUMINATES	
A. Limiter open in associated relay coil circuit.	Check associated 5-ampere limiter in dc distribution box. If open replace and check system operation.
B. Defective circuit wiring.	Check wiring for ground short between light and relay. If a short is found repair or replace wiring.
C. Defective indicator light assembly.	Check assembly for short. If defective replace and check system operation.
D. Defective bus off light relay.	Replace relay with one of known quality. Check system operation and send defective relay to overhaul shop.
4. NO INDICATION ON T-R AMMETER	
A. T-R control switch off.	Check for proper switch position. If incorrect place in on position and check system operation.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
4. NO INDICATION ON T-R AMMETER (CONT)	
B. Reverse current relay contacts open.	Check T-R unit output voltage. If voltage is below normal, replace with one of known quality. Check system operation and return defective unit to overhaul shop.
C. Defective circuit wiring.	Check circuit continuity between ammeter and T-R unit. If no continuity, repair or replace wiring.
D. Defective ammeter.	Replace ammeter with one of known quality. Check system operation and send defective meter to overhaul shop.

DC POWER SUPPLY SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test DC Power Supply System

A. Equipment Required - External ac power unit

B. Preparation.

(1) Check the following switches for the positions indicated:

(a) Battery switch - OFF.

(b) T-R switches No. 1, 2, 3, and 4 - OFF.

(c) DC voltmeter selector switch - OFF.

(d) Essential bus connect switch - NORMAL.

(2) Energize the external ac power system (refer to 24-3-0, Adjustment/Test).

C. Test DC Power Supply System.

(1) Place T-R control switches No. 1, 2, and 3 in the ON position.

(a) The T-R unit ammeters shall indicate from 1 to 10 amperes.

(b) The dc voltmeter shall indicate from 24.5 to 30 volts at all selector switch positions.

(2) Place the No. 1 and 2 T-R control switches in the OFF position and the battery switch to the NORMAL position.

(a) The ammeter readings for the No. 1 and 2 T-R units shall be zero.

(b) The ESS BUS OFF indicator light shall illuminate.

(3) Place the No. 1 and 2 T-R control switches in the ON position.

(a) Ammeter indication for the No. 1 and 2 T-R units reading shall be from 1 to 10 amperes.

(b) The ESS BUS OFF light shall extinguish.

(4) Place the No. 3 and 4 T-R unit control switches in the OFF position.

(a) Ammeter readings for the No. 3 and 4 T-R units shall be zero.

(b) The EMER BUS OFF indicator light shall illuminate.

(5) Place the No. 3 and 4 T-R unit control switches in the ON position.

(a) Ammeter readings for the No. 3 and 4 T-R units shall be from 1 to 10 amperes.

(b) The EMER BUS OFF light shall extinguish.

(6) Return all switches to the configurations listed in preparation step B.(1).

(7) Turn the external power control switch OFF. All indicator lights in the flight compartment except the MAIN and AUXILIARY-CONN external power lights shall extinguish.

(8) Turn off external power unit. All system indicator lights shall extinguish.

T-R UNIT - MAINTENANCE PRACTICES

1. Removal/Installation T-R Unit (see Figure 201)

   A. Equipment Required - None.

   B. Remove T-R Unit.

      (1) Remove all airplane power.

      (2) Remove safety wire from electrical connector and the two knurled retaining nuts.

      (3) Remove electrical connector.

      (4) Remove two screws securing terminal block cover on front panel of unit.

      (5) Remove hardware from terminal studs and remove wires.

      (6) Remove screw securing bonding jumper to rack.

      (7) Loosen knurled retaining nuts and slide unit from shelf.

   C. Install T-R Units.

      (1) Place T-R unit in position in top shelf of electric rack.

      (2) Attach bonding jumper removed in step B.(6).

      (3) Tighten knurled retaining nuts.

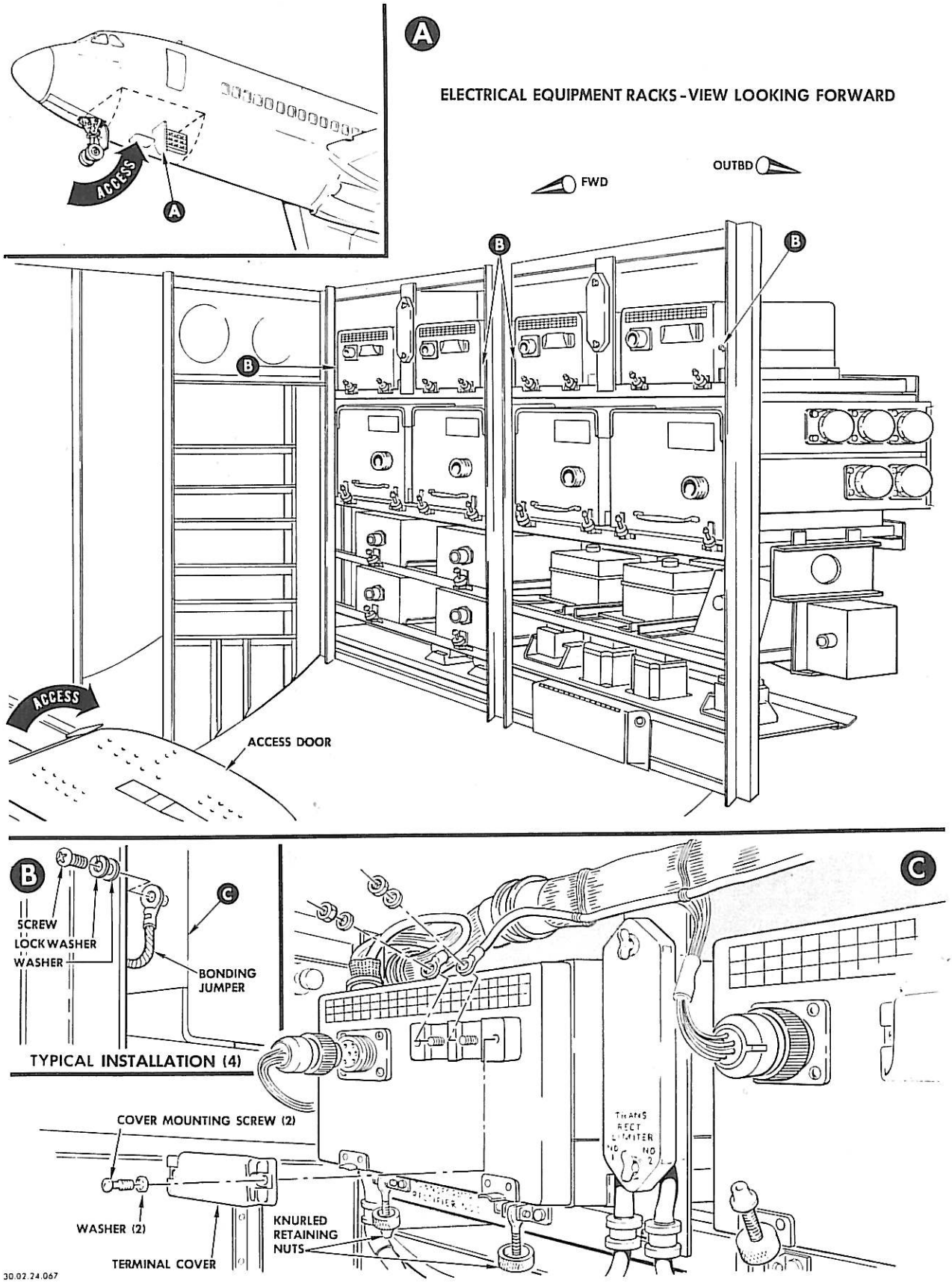
      (4) Replace two wires on terminal block and replace hardware.

      (5) Replace terminal block cover and secure with two screws.

      (6) Replace and tighten electrical connector; safety-wire connector.

      (7) Turn on airplane power.

      (8) Test system operation (refer to Section 24-5-0, Adjustment/Test).


A
ELECTRICAL EQUIPMENT RACKS - VIEW LOOKING FORWARD
ACCESS
A
FWD
OUTBD
B
B
B
ACCESS
ACCESS DOOR
B
C
SCREW
LOCKWASHER
WASHER
BONDING JUMPER
TYPICAL INSTALLATION (4)
C
COVER MOUNTING SCREW (2)
WASHER (2)
KNURLED RETAINING NUTS
TERMINAL COVER
30.02.24.067

REVERSE CURRENT RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Reverse Current Relay (see Figure 201)

   A. Equipment Required - None.

   B. Remove Reverse Current Relay.

      (1) Remove all airplane power.

      (2) Remove bus bars and wires.

      (3) Remove four mounting screws.

      NOTE: Identify screw to which bonding jumper is attached.

   C. Install Reverse Current Relay.

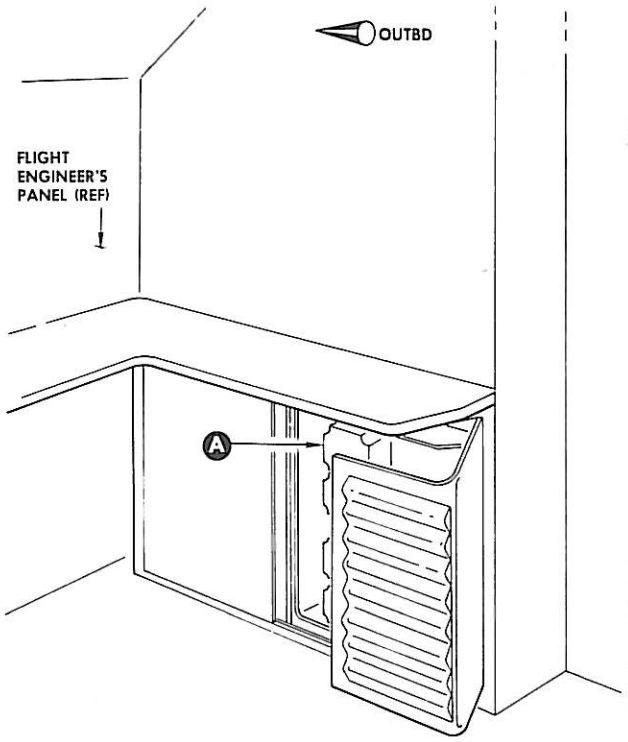
      (1) Place relay in proper position and install mounting screws.

      NOTE: Be sure to attach bonding jumper under proper mounting screw.

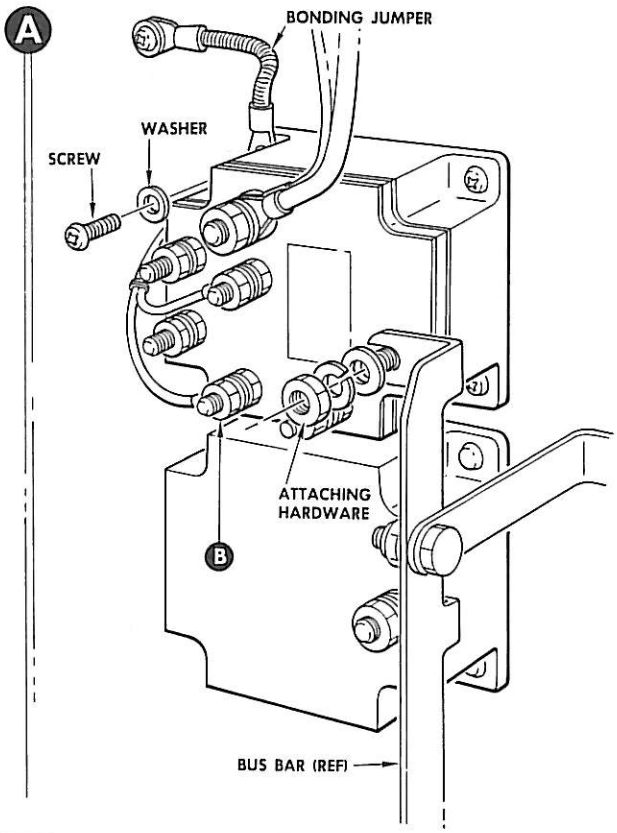
      (2) Connect all wires and bus bars.

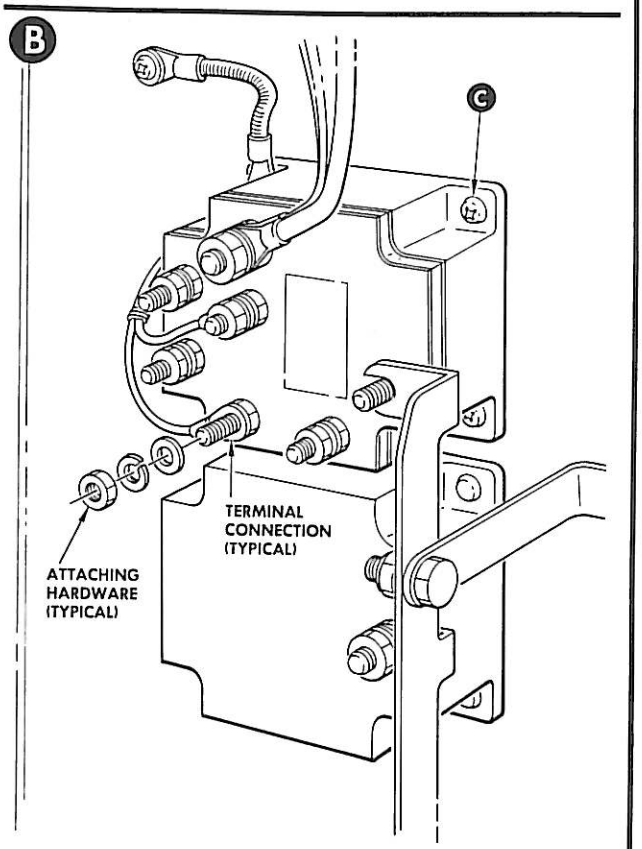
      (3) Turn on airplane power.

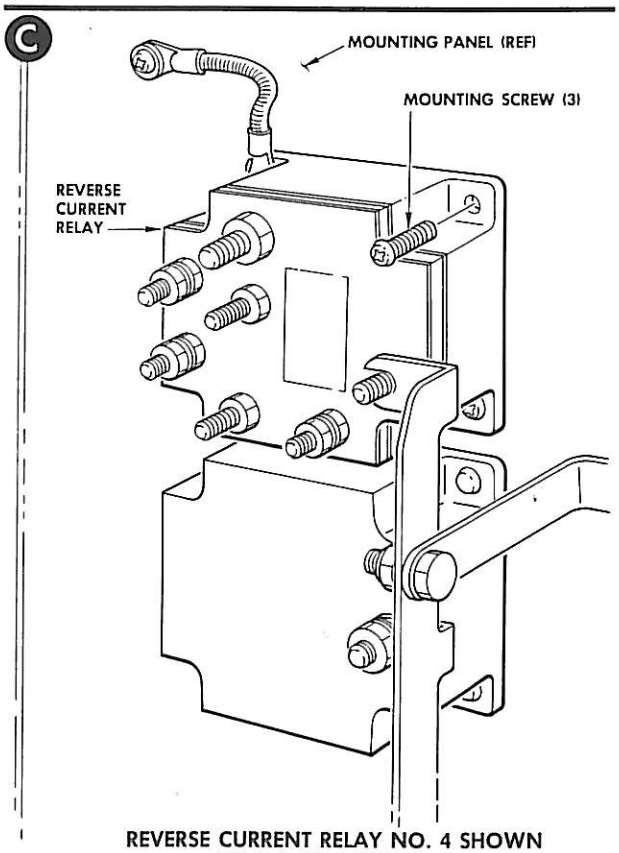
      (4) Test unit operation (refer to Section 24-5-0, Adjustment/Test).



MAIN CIRCUIT BREAKER PANEL
(VIEW LOOKING AFT—FLIGHT COMPARTMENT)







REVERSE CURRENT RELAY NO. 4 SHOWN
(NO. 3, 2 AND 1 SIMILAR)

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BUS LIGHT OFF RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Bus Light Off Relay (see Figure 201)

   A. Equipment Required - None.

   B. Remove Bus Light Off Relay.

      (1) Remove all airplane power.

      (2) Remove screws securing relay to panel.

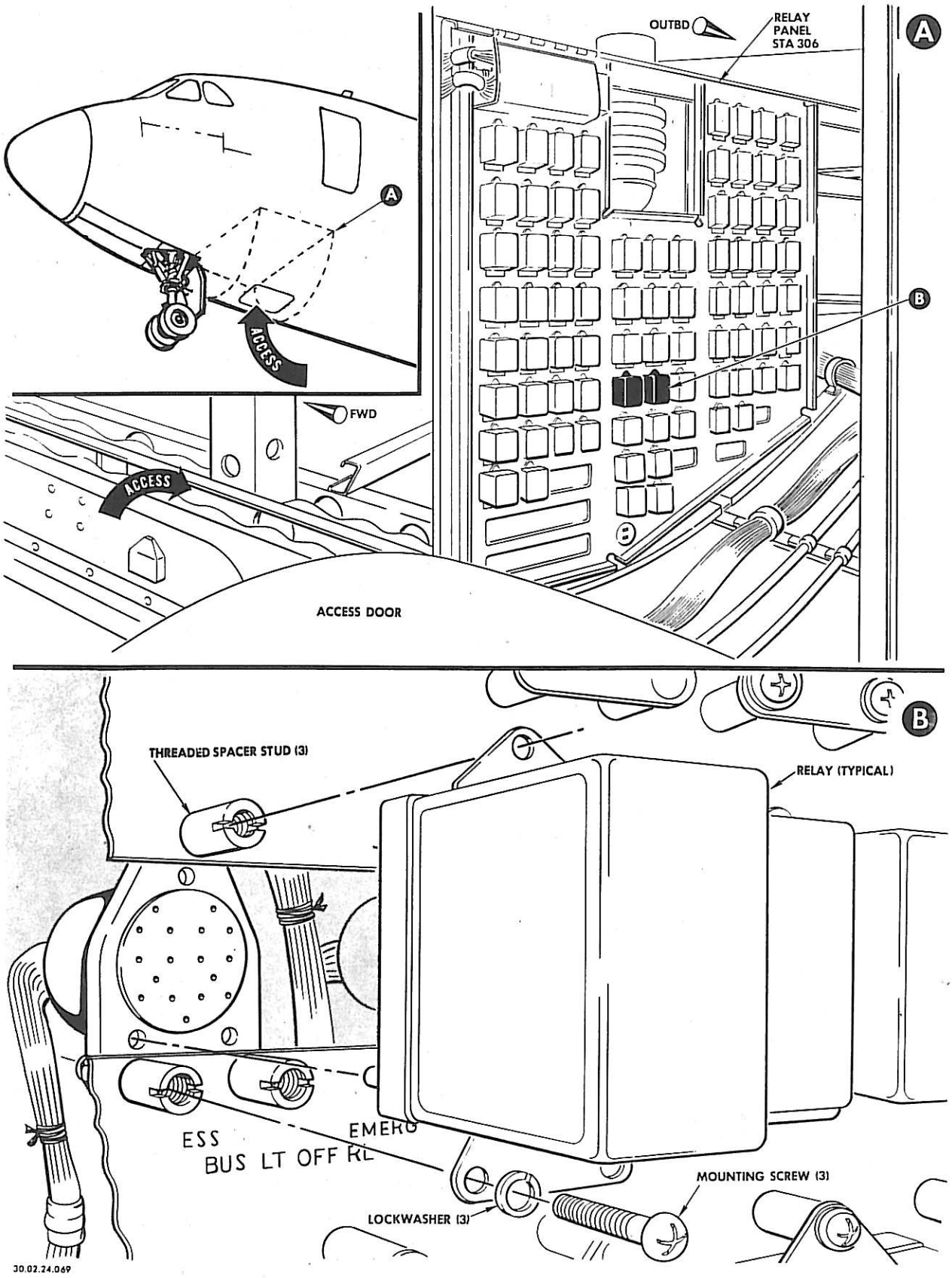
      (3) Remove relay.

   C. Install Bus Light Off Relay.

      (1) Place relay in position and install mounting screws.

      (2) Turn on airplane power.

      (3) Test system operation (refer to Section 24-5-0, Adjustment/Test).



Bus Light OFF Relay Installation
Figure 201

EMERGENCY DC POWER SYSTEM - DESCRIPTION AND OPERATION

1. Description

The emergency dc system consists of a battery, a battery control switch, a reverse current relay, an ammeter, a shunt, a battery bus, a battery distribution bus, limiters, a battery relay, an essential bus connect switch, and the interconnecting circuitry. The battery, reverse current relay, battery relay, battery bus, shunt, and limiters are located in the upper forward nose section and are not accessible in flight. The battery system circuitry has been kept to a minimum due to the integrity of the ac power system and the transformer-rectifier (T-R) units.

2. Operation and Distribution (see Figure 1)

If a malfunction causes the loss of all T-R units, the 28-volt dc emergency bus is energized with battery power by placing the battery control switch in the EMER position. This switch action applies battery power to the coil of the battery relay. The battery relay closes routing battery power from the battery distribution bus to the 28-volt dc emergency bus. Circuits that normally are supplied by the 28-volt dc emergency bus are again ready for use. The 28-volt dc essential bus may be connected to the emergency bus by placing the ESS BUS RELAY switch in the CLOSE position. This switch action routes power from the battery distribution bus to the coil of the essential dc bus connect relay. The essential dc bus connect relay closes connecting the 28-volt dc essential bus to the 28-volt dc emergency bus. Power for the emergency lights, main fire extinguisher, and warning horn circuits is supplied directly from the battery distribution bus.

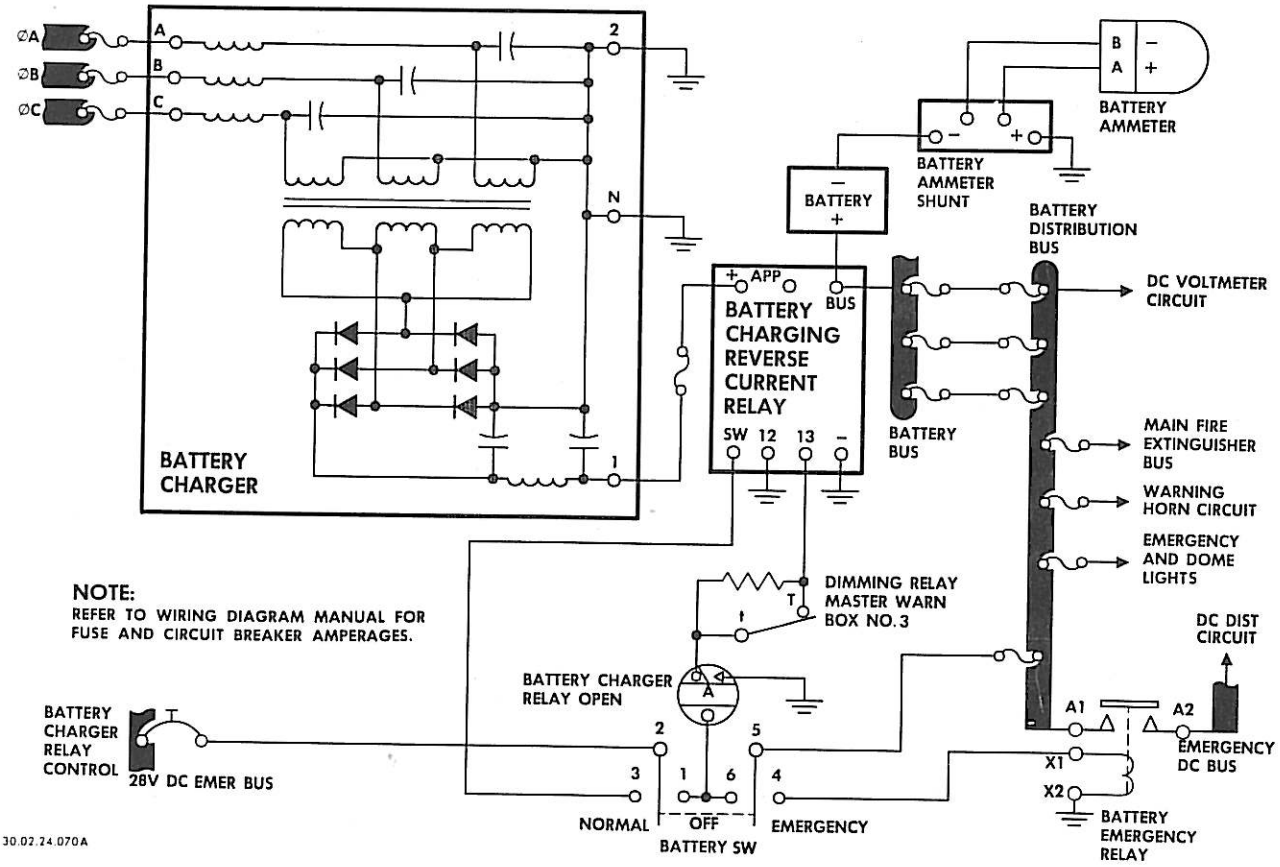
When the 28-volt dc essential bus deenergizes the essential bus "off" light illuminates. With the switch in the emergency position, power is removed from the actuating coil of the battery reverse current relay and the relay contacts open. This removes the charging current provided by the battery T-R unit and closes the contacts for illumination of the CHARGER RELAY OPEN light.

Voltage readings are available directly from the battery at any time by the voltmeter selector switch. When the switch is rotated to the BATT position, the existing battery voltage is indicated on the voltmeter. The battery ammeter connects to the battery shunt to indicate the load on the battery system when energized.

3. Battery

A. Description.

A 27.5-volt, 13.5-ampere hour, nickel-cadmium battery powers the emergency dc system. The battery is located on the right side of the fuselage, forward of the copilot's instrument panel. Access is made through the door in the overhead of the forward end of the nose wheel well.



Battery Bus Distribution Schematic
Figure 1

The battery contains 22 cells which provide the specified voltage. Each cell consists of a core assembly made from a series of positive and negative plates separated by a continuous strip of two layers of nylon and a layer of cellophane. The core assembly is affixed to a plastic cover and fitted into a plastic case. The outside of the cover contains a positive and negative terminal post and a cell cap.

Integral with the cell cap is a vent which permits the gas created during charging to escape. Venting is accomplished by a rubber sleeve stretched over a vent hole in the small vertical protrusion in the center of the cell cap. The rubber expands with gas pressure and allows it to escape. When no pressure is present in the cell, the rubber sleeve prevents electrolyte leakage during discharge even in an inverted position. This sleeve also prevents dirt or dust from entering the cell.

The electrolyte is a 30 percent-by-weight solution of potassium hydroxide (KOH) in distilled water. The specific gravity reading of the electrolyte for a fully charged battery should be from 1250 to 1300. The electrolyte level should be at the top of the splash plate. This level is visually checked by removing the cell cap.

The cells bus together in series and connect to the airplane circuitry through a connector plug. This plug is connected or removed by turning a knob that drives a threaded shaft into a threaded insert on the battery case receptacle. The connector has two female inserts which fit over two male pins protruding from the battery case receptacle.

B. Handling.

The following points should be adhered to when working with the battery:

(1) Never use tools on the battery which have been used when working with a lead-acid battery.

(2) Add distilled water only. The proper time to check water level is three or more hours after completion of a charge.

(3) Normally, it should not be necessary to check specific gravity since there is no appreciable change in specific gravity with change in the state of charge.

NOTE: In critically low temperature operation, it may be desirable to check specific gravity. Always use a clean hydrometer that has not been in contact with acid. If specific gravity is below 1250, add 1320 specific gravity potassium hydroxide (KOH), reagent grade, to bring the liquid level to the top of the splash plate or level line.

(4) The battery can be discharged in any position without fear of leakage, but must be charged in an upright position.

(5) Do not charge individual cells without supporting the cell case externally.

(6) The integral vent allows charging gas to escape; however, it will not leak liquid even if discharged in an inverted position.

(7) Normally, the batteries will remain externally clean if unattended except for possible gathering of dust, etc. If overcharging is heavy, gassing and bubbling of electrolyte through the vent may result in the formation of a white substance on the top of the cell. This is harmless potassium carbonate and may be removed by dry brushing or washing the battery with water.

(8) If electrolyte is accidentally spilled from an open cell on hands, clothing, or other material, wash with cold water or a boric acid solution.

4. Battery Control Switch

The battery control switch is located on the flight engineer's dc control panel and is incorporated in the battery system to initiate current flow from the battery to the emergency bus. The three-position switch is labeled NORMAL-BATT OFF-EMER. In the NORMAL position, power from the 28-volt dc emergency bus is supplied to the SW contact of the battery reverse current relay, and battery power is routed to the system warning lights. The switch should be placed in the BATT OFF position when the airplane is not in use. In the EMER position, power from the 28-volt dc emergency bus is supplied to the system warning lights, and current from the battery is routed to the actuating coil of the battery relay. For removal/installation of the battery control switch, refer to section 24-2-6.

EMERGENCY DC POWER SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. CHARGER RELAY LIGHT FAILS TO ILLUMINATE WITH BATTERY CONTROL SWITCH IN EMERGENCY	
A. Open limiter.	Check applicable 10-ampere limiter. If open, replace limiter and check operation.
B. Faulty bulb.	Check press-to-test feature. If no light replace bulb.
C. Airplane wiring defective.	If bulb lights on press-to-test check, make a continuity check on airplane wiring between light and battery distribution bus. If no continuity, replace or repair wiring.
2. NO VOLTAGE ON DC VOLTMETER WITH SELECTOR SWITCH IN BATTERY POSITION	
A. Open circuit breaker.	Close circuit breaker and check system operation.
B. Faulty wiring.	Check circuit continuity between battery bus, voltmeter selector switch, and voltmeter. If no continuity repair or replace wiring.
C. Defective battery.	Remove battery connector plug and check battery with voltmeter. If no voltage replace battery and check system operation.
D. Defective voltmeter.	Check other voltmeter selector switch positions with T-R units on. If no readings replace voltmeter. Check system operation.
3. NO VOLTAGE ON EMERGENCY BUS WITH BATTERY CONTROL SWITCH IN EMERGENCY	
A. Open limiter at battery distribution bus connection that routes battery power to control switch.	Check limiter. If open, replace and check system operation.
B. Defective wiring between control switch and battery relay.	Check continuity from switch to relay and from switch to battery bus. If no continuity repair or replace wiring.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. NO VOLTAGE ON EMERGENCY BUS WITH BATTERY CONTROL SWITCH IN EMERGENCY (CONT)	
C. Defective battery relay.	Check for continuity across relay contacts with relay energized. If no continuity, replace relay. Check system operation and send defective unit to overhaul shop.
D. Open limiters between battery and battery distribution bus.	Check limiter(s). If open, replace and check system operation.
4. NO INDICATION ON BATTERY AMMETER WITH BATTERY CONTROL SWITCH IN EMERGENCY AND POWER ON THE EMERGENCY BUS	
A. Loose connections on ammeter shunt.	Check security of connections. Tighten as necessary.
B. Defective shunt.	Replace shunt.
C. Defective wiring.	Check for continuity between shunt and ammeter. If no continuity repair or replace wiring.
D. Defective ammeter.	Replace ammeter with one of known quality. Check system operation.

EMERGENCY DC POWER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Emergency DC Power System

A. Equipment Required - None.

B. Preparation.

(1) Place external power control switch in the OFF position.

(2) Place battery control switch in OFF position.

(3) Close BATT CHGR REL CONT circuit breaker.

(4) Place essential bus connect switch in NORMAL.

C. Test Emergency DC Power System.

(1) Place DC voltmeter selector switch in the BATT position. Dc voltmeter shall indicate 24.5 to 30 volts.

(2) Place battery control switch in the EMER position.

(a) Charger relay open light shall illuminate.

(b) 28-volt dc essential bus OFF light shall illuminate.

(c) 28-volt dc emergency bus OFF light shall be extinguished.

(d) Battery ammeter shall indicate 1 to 30 amperes, depending on the number of dc circuits energized.

(3) Momentarily place essential bus connect switch in CLOSE and then back to NORMAL. The essential bus OFF light should extinguish and then illuminate.

CAUTION: DO NOT OPERATE BATTERY POWER CIRCUIT FOR EXTENDED PERIODS BECAUSE IT IS NOT INTENDED FOR SUCH USE.

(4) Place battery control switch in the OFF position.

(a) All warning lights shall extinguish.

(b) The BATT position on the dc voltmeter shall still indicate 24.5 to 30 volts.

(c) Battery ammeter shall indicate zero.

BATTERY - MAINTENANCE PRACTICES

1. Removal/Installation Battery (see Figure 201)

   A. Equipment Required - None.

   B. Remove Battery.

      (1) Check to see that the battery control switch is in the BATT OFF position.

      (2) Turn battery cable connector-knob counterclockwise until cable-connector knob inserts are completely disengaged from pins protruding from the battery case receptacle.

      (3) Loosen two battery retaining clamps.

      (4) Remove the two retaining clamps and hold-down strap; remove battery.

   C. Install Battery.

      (1) Place battery in proper position on mounting base.

      (2) Place hold-down strap in proper position and tighten retaining clamps.

      (3) Align cable-connector-knob inserts with battery receptacle pins and turn cable connector knob clockwise until secure.

      (4) Test system operation (refer to 24-6-0, Adjustment/Test).

2. Adjustment/Test Battery

   A. General.

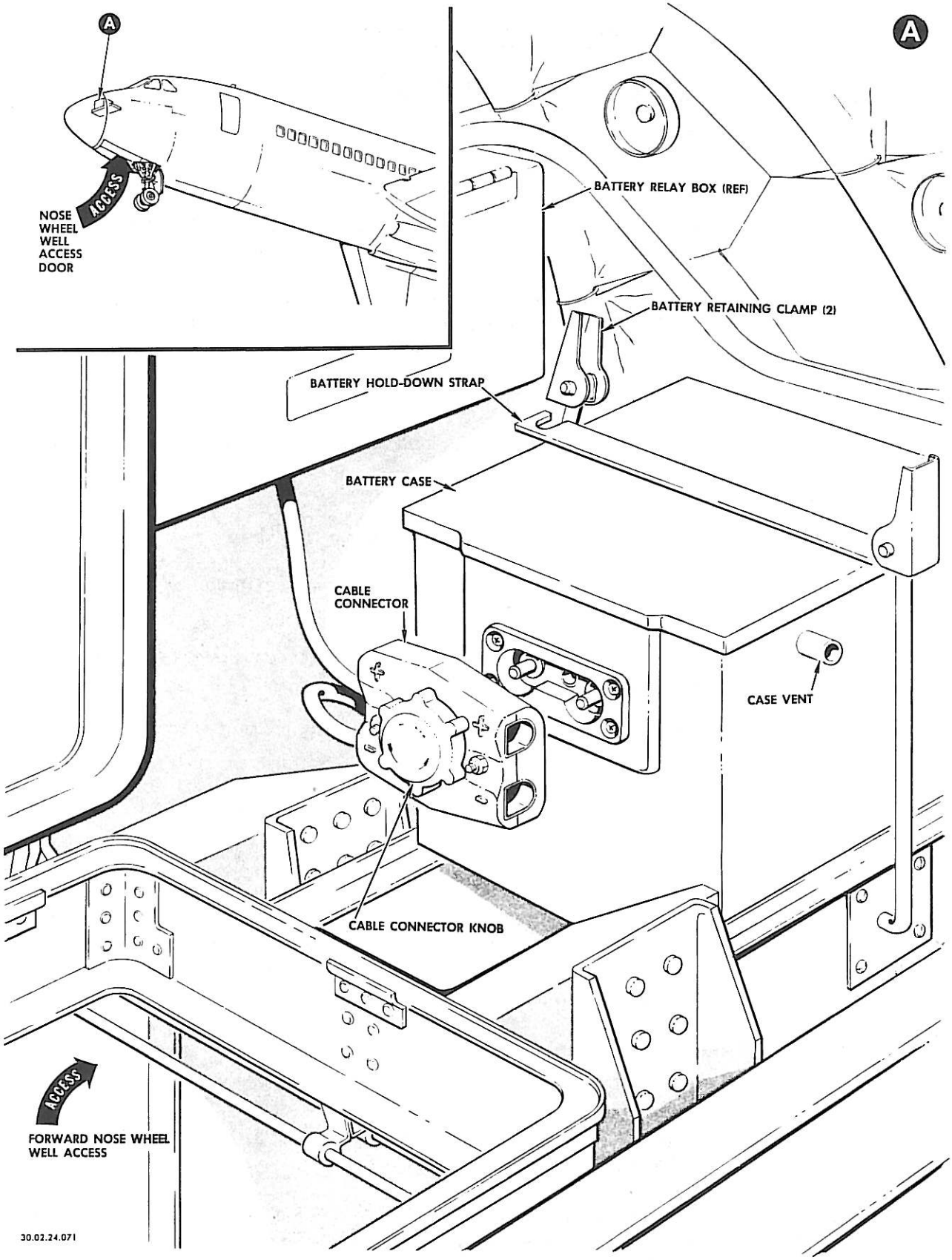
      The state of charge of a nickel-cadmium battery cannot be determined by the battery voltage or by the specific gravity of the electrolyte. The only true indication of the state of charge of the nickel-cadmium battery is the amount of current that the battery draws when connected to a constant potential charging bus. The higher the state of charge, the lower the charging current and vice versa.

   B. Equipment Required - None.

   C. Test Battery.

      (1) Energize the external ac power system (refer to Section 24-3-0, Adjustment/Test.)

      (2) Place the dc voltmeter selector switch on the flight engineer's dc control panel in the BATT position. The voltmeter shall indicate approximately 27.5 volts.



Battery Installation
Figure 201

(3) Check that the pilots' ac essential bus selector switch is in the EXT PWR position.

(4) Actuate the battery control switch to the NORMAL position.

(a) The battery CHARGER RELAY OPEN light shall extinguish.

(b) The battery ammeter shall indicate from plus 1 to 10 amperes for a short time and then return to approximately zero.

(c) This indicates the state of battery charge is good.

(d) If a high amperage reading continues on the ammeter it is an indication that either the battery or a cell is damaged and must be replaced.

(5) Place the battery control switch in the OFF position.

(a) The battery ammeter indication shall be zero.

(b) The CHARGER RELAY OPEN light shall extinguish.

(6) Deenergize the external ac power system.

REVERSE CURRENT RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Reverse Current Relay (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open BAT CHGE REL CONT circuit breaker and move pilots' ac essential bus selector switch to any position except EXT PWR.

      (2) Gain access to battery in right-hand nose section, station 165.

      (3) Turn battery connector knob counterclockwise and remove connector.

   C. Remove Reverse Current Relay.

      (1) Release two fasteners on cover of battery relay and limiter box and raise cover.

      (2) Remove wires from relay terminals.

      (3) Remove nuts and washers from bus bar terminals of reverse current relay and battery relay.

      (4) Remove the limiter bus bar nuts and washers.

      (5) Remove bus bar.

      (6) Remove mounting screws from base of reverse current relay.

      NOTE: Identify screw to which bonding jumper is attached.

      (7) Remove reverse current relay.

   D. Install Reverse Current Relay.

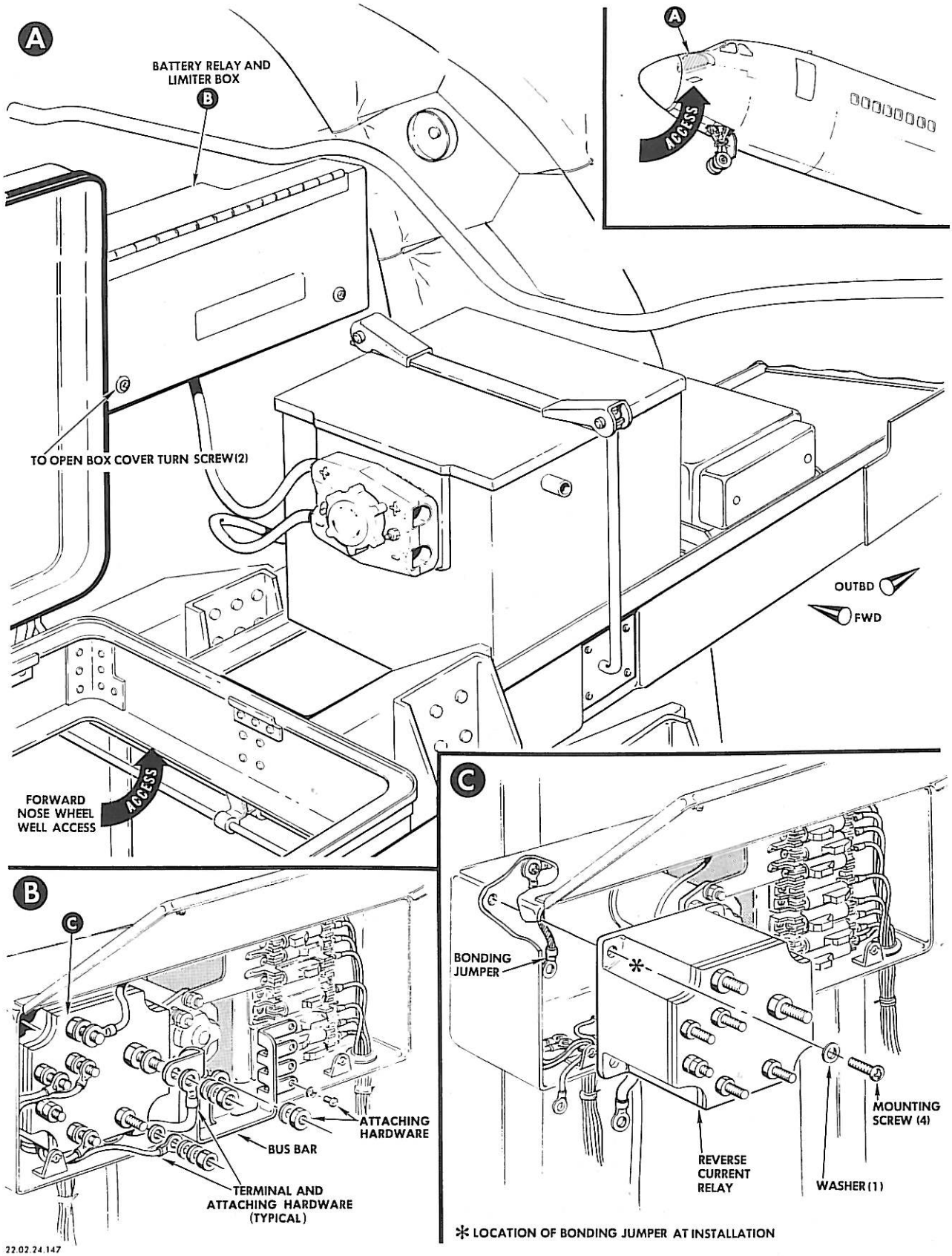
      (1) Position replacement relay over mounting holes and install screws in holes of relay base.

      NOTE: Be sure to attach bonding jumper under proper mounting screw.

      (2) Position bus bar over terminals of reverse current relay, battery relay and limiters. Install nuts and washers removed in steps C. (3) and (4).

      (3) Replace wires on reverse current relay.

      (4) Close battery relay and limiter box cover and secure fasteners.



Battery Reverse Current Relay Installation
Figure 201

(5) Install battery connector on battery.

(6) Close BAT CHGR REL CONT circuit breaker and place the pilots' ac essential bus selector switch to EXT PWR.

(7) Test system operation (refer to Section 24-6-1, Adjustment/Test).

BATTERY TRANSFORMER-RECTIFIER - MAINTENANCE PRACTICES

1. Removal/Installation Battery Transformer-Rectifier (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open BAT CHGR REL CONT circuit breaker and move pilots' ac essential bus selector switch to any position except EXT. PWR.

      (2) Gain access to battery in right-hand nose section, station 165.

      (3) Turn battery connector knob counterclockwise and remove connector.

   C. Remove Transformer-Rectifier.

      (1) Remove two screws from terminal board cover and remove cover.

      (2) Remove nuts and washers from terminals and remove wires.

      (3) Remove the four screws that secure transformer-rectifier to shelf. Remove transformer-rectifier.

   D. Install Transformer-Rectifier.

      (1) Position replacement transformer-rectifier over mounting holes in shelf.

      (2) Install four screws in base of transformer-rectifier.

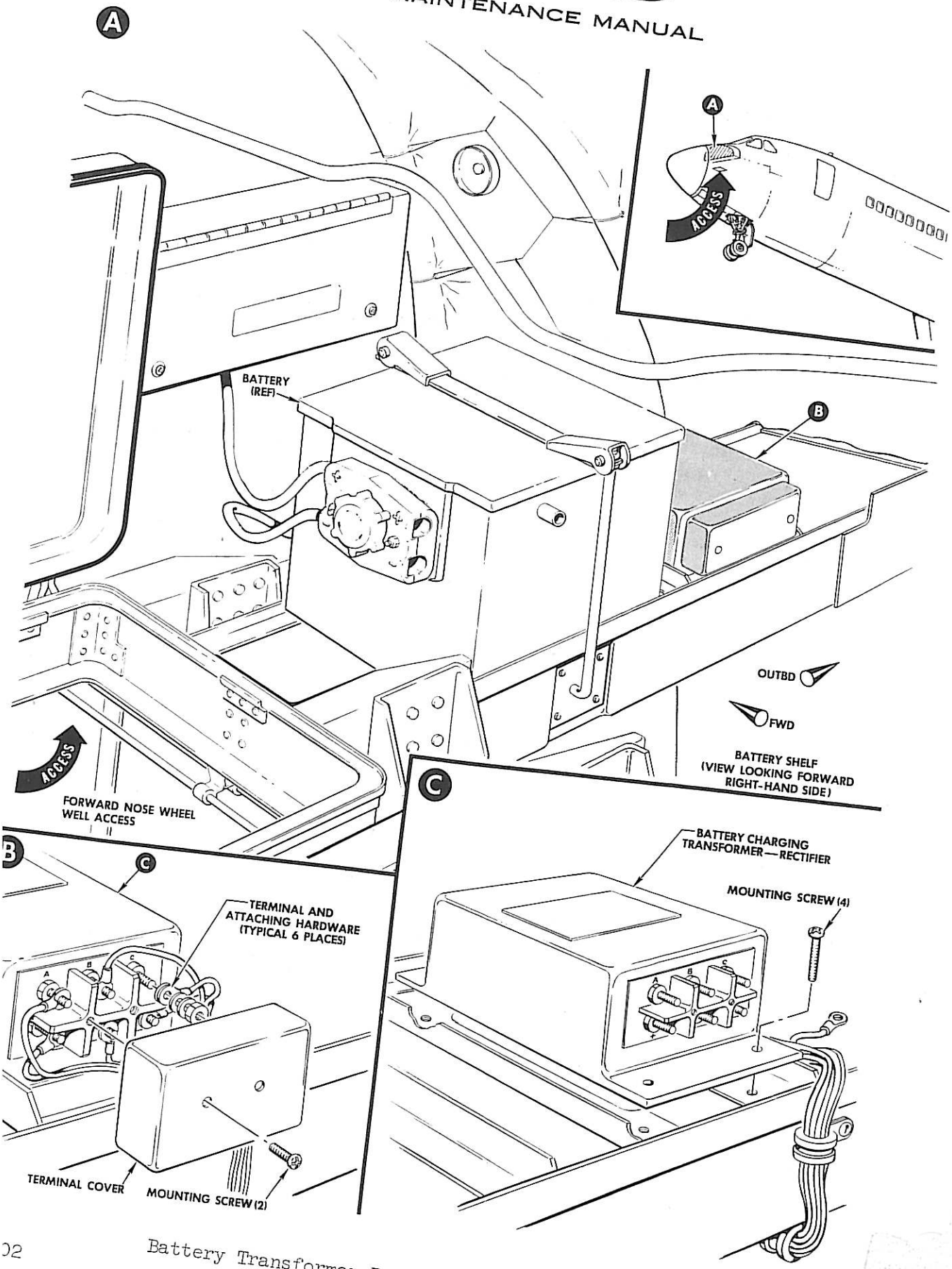
      (3) Position wires on terminal board and secure with nuts and washers.

      (4) Replace terminal board cover and secure with two screws.

      (5) Connect battery connector to battery.

      (6) Close BAT CHGR REL CONT circuit breaker and place pilots' ac essential bus selector switch to EXT PWR.

      (7) Test system operation, (refer to 24-6-0, Adjustment/Test).



Battery Transformer-Rectifier Installation
Figure 201

BATTERY RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Battery Relay (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open BAT CHGR REL CONT circuit breaker and move pilots' ac essential but selector switch to any position except EXT PWR.

      (2) Gain access to battery in right-hand nose section, station 165.

      (3) Turn battery connector knob counterclockwise and remove connector.

   C. Remove Battery Relay.

      (1) Release two fasteners on cover of battery relay and limiter box and raise cover.

      (2) Remove wires from battery relay terminals.

      (3) Remove nuts and washers from bus bar terminals of battery relay and reverse current relay.

      (4) Remove the limiter bus bar nuts and washers.

      (5) Remove bus bars.

      (6) Remove mounting screws from relay mounting holes.

      NOTE: Identify screw to which bonding jumper is attached.

      (7) Remove battery relay.

   D. Install Battery Relay.

      (1) Position replacement battery relay over mounting holes and install mounting screws.

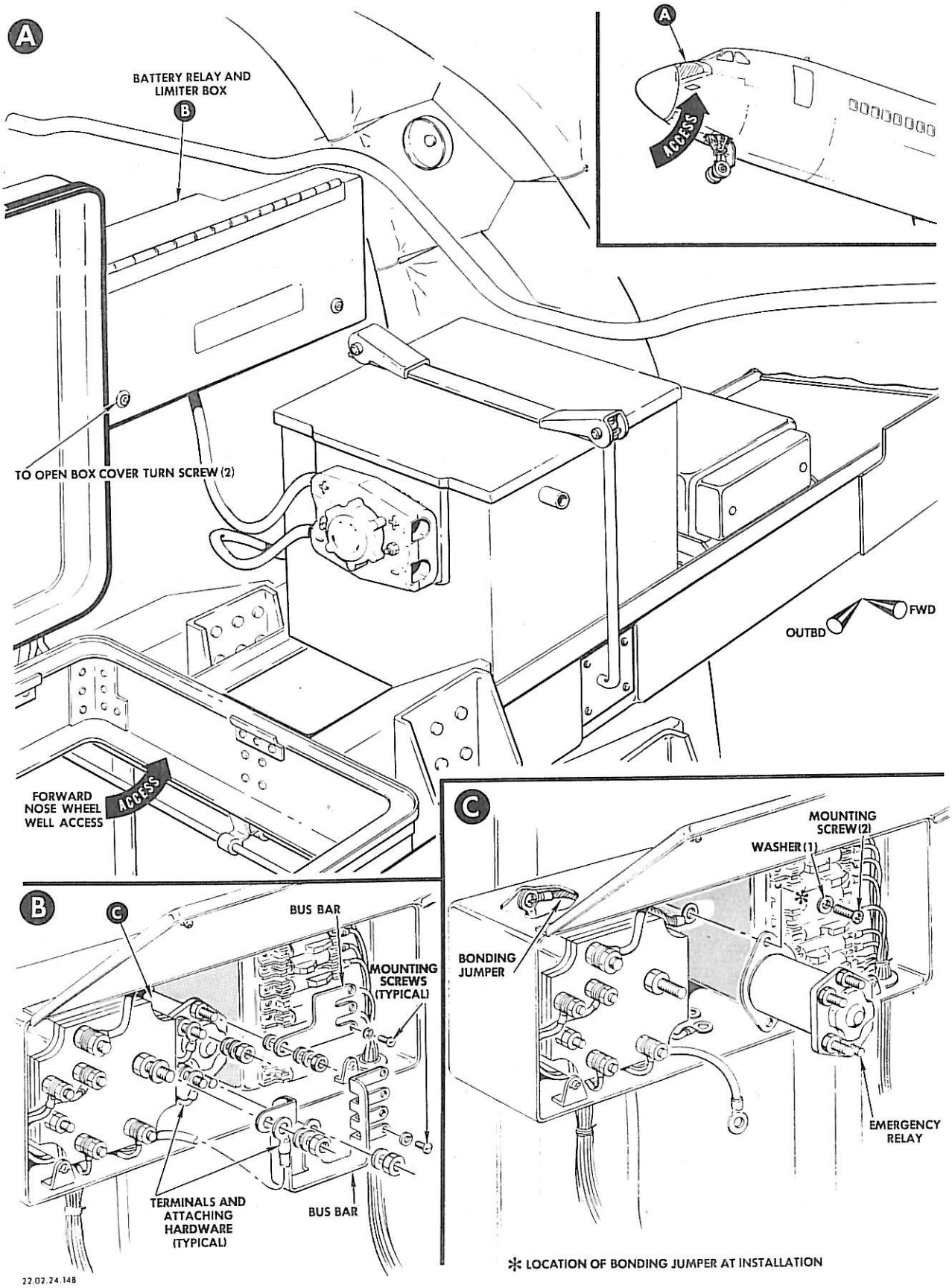
      NOTE: Be sure to place bonding jumper under proper mounting screw.

      (2) Position bus bars over reverse current relay, battery relay and limiters. Secure with nuts and washers removed in steps C. (3) and (4).

      (3) Replace wires on battery relay terminals.

      (4) Close battery relay and limiter box cover and secure fasteners.

      (5) Install battery connector.


A
BATTERY RELAY AND LIMITER BOX
B
TO OPEN BOX COVER TURN SCREW (2)
FORWARD NOSE WHEEL WELL ACCESS
ACCESS
OUTBD
FWD
B
C
BUS BAR
MOUNTING SCREWS (TYPICAL)
TERMINALS AND ATTACHING HARDWARE (TYPICAL)
BUS BAR
C
MOUNTING SCREW (2)
WASHER (1)
BONDING JUMPER
EMERGENCY RELAY
* LOCATION OF BONDING JUMPER AT INSTALLATION
22.02.24.14B

(6) Close BAT CHGR REL CONT circuit breaker and place the pilots' ac essential bus selector switch in EXT PWR.

(7) Test system operation, (refer to Section 24-6-0, Adjustment/Test).

EMERGENCY AC STATIC INVERTER SYSTEM - DESCRIPTION AND OPERATION

1. Description

The emergency ac static inverter system produces regulated ac power for instrumentation and ignition. The system comprises a static inverter, a control switch, a control relay, an indicator light and two power transfer relays. The system provides ac power to a limited number of circuits only during in-flight emergencies when the pilots' ac essential bus is de-energized.

2. Operation (see Figure 1)

Power for inverter operation is supplied from the 28-volt dc emergency bus through a 30-ampere limiter in the dc power distribution box. When the control switch is placed in the ON position the control relay is energized which, in turn, energizes the inverter. Inverter output power energizes the power transfer relays allowing the normally open contacts to close and route inverter power to the various engine circuits. The two indicator lamps illuminate when the inverter is operating.

CAUTION: DO NOT OPERATE INVERTER FOR PERIODS EXCEEDING 12 MINUTES REGARDLESS OF LOAD. DEENERGIZE INVERTER AFTER TEST AND ALLOW A MINIMUM OF ONE HOUR BETWEEN OPERATIONS.

NOTE: If the static inverter system is used during ground operation the battery should be checked for sufficient capacity for emer- in-flight use. The check can be made by observing the rate-of-charge. When the ammeter needle drops below 3 amperes the battery is considered to be adequately charged.

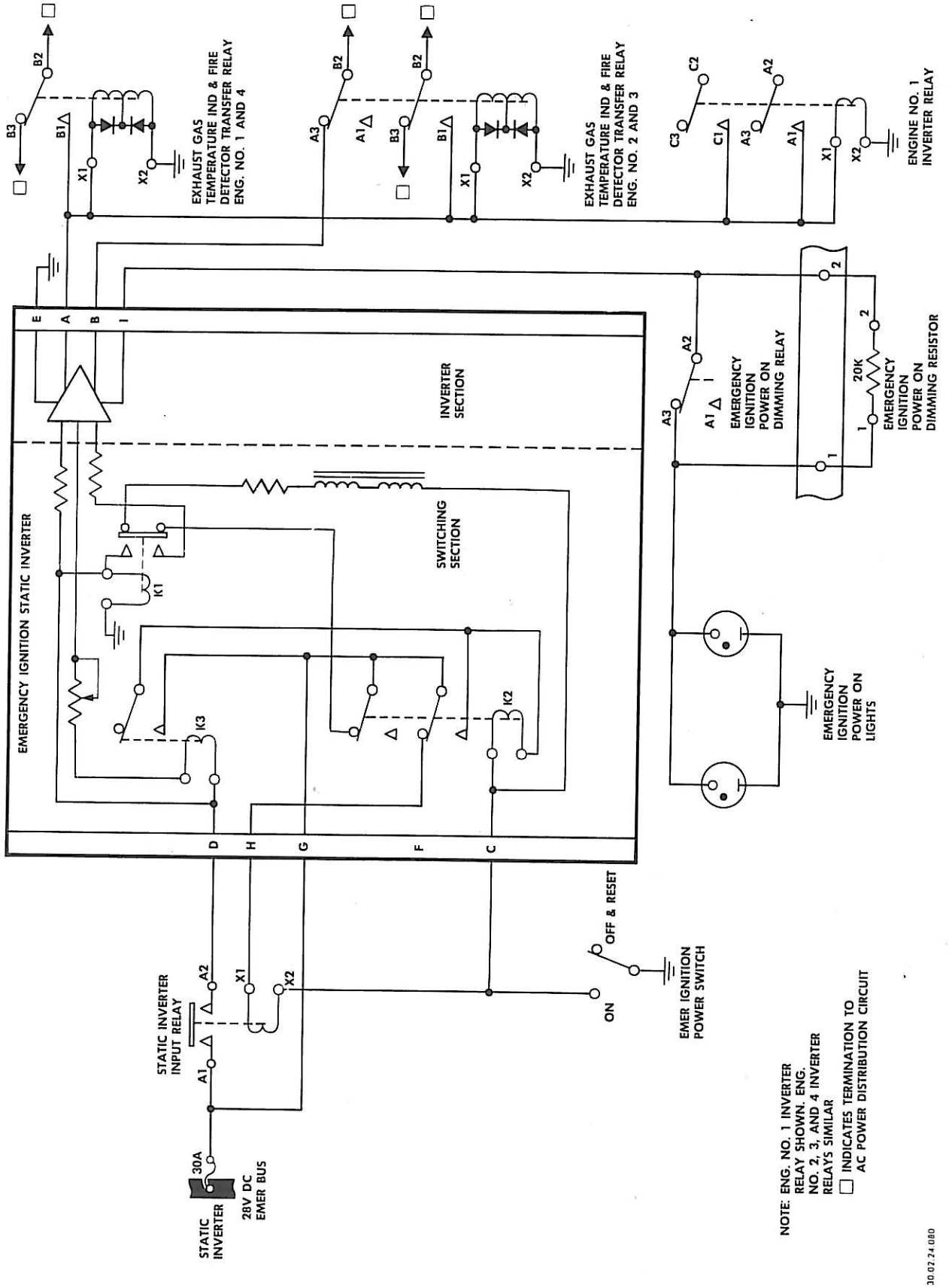
3. Static Inverter Power Distibution

The following circuits receive ac power from the static inverter:

Engine Ignition Power Circuit - 115-volts ac
Engine Ignition Control Circuit - 115-volts ac
Engine Exhaust Gas Temperature Indicator Circuit - 115-volts ac
Engine Fire Detector Circuit - 115-volts ac
Fuel Flow Amplifier Circuits - 115-volts ac
Hydraulic Brake Pressure Indicator Circuit - 26-volts ac

4. Static Inverter

The static inverter converts 28-volt dc power supplied by the battery to 115-volt 400 cps power. The inverter will supply 250 VA at a 0.54 to 0.8 power factor for 10 minutes followed by a load of 725 VA at a 0.5 to 0.7 power factor for two minutes. The inverter contains special circuits which perform protective functions for initial buildup and output short circuits.



Emergency Ignition Static Inverter Circuit
Figure 1

A. Initial Buildup. Control of initial buildup prevents saturation of the oscillator transformer. This is accomplished by two auxiliary windings on the oscillator transformer and a relay. The circuit puts out one quarter of a cycle only on the first starting cycle.

B. Output Short Circuits. If a short circuit exists the current will build up on the dc input. This is sensed by a relay which drops out the external power relay and removes the dc input from the inverter.

5. Control Switch

A two position toggle switch labeled EMER IGN PWR, ON - OFF RESET on the pilots' overhead switch panel controls static inverter operation. The actuated switch completes the ground circuit for the control relay coil.

6. Control Relay

A control relay for the static inverter is located in the dc power distribution box at station 294. When the control switch is placed in the ON position the control relay energizes and power routes from the 28-volt dc emergency bus through a 30-ampere limiter, through the closed contacts of the relay and then to the inverter.

7. Indicator Light

An indicator light labeled EMER IGN PWR ON is located on the pilots' overhead switch panel beside the control switch. The light contains two incandescent lamps which illuminate when the static inverter system is operating. A dimming resistor is incorporated in the system to allow a reduction of lamp brilliance when the dimming system is energized.

8. Power Transfer Relays

Two relays located on the relay panel at station 306 transfer power from the static inverter to various circuits. These relays are labeled EXHAUST GAS TEMPERATURE IND & FIRE DETECTOR TRANSFER RELAYS. The relay coils are energized when the static inverter system is turned on. The 115-volt or 26-volt ac output power from the static inverter then routes through the closed relay contacts to the circuits listed in paragraph 3.

EMERGENCY AC STATIC INVERTER SYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. SYSTEMS POWERED BY STATIC INVERTER DO NOT OPERATE WITH STATIC INVERTER SYSTEM ON AND INDICATOR LIGHT OFF	
A. Open limiter.	Check static inverter limiter in dc power line. If open, replace limiter.
B. Faulty inverter.	Check for 115 volts ac at pin A, 26 volts ac at pin B, 28 volts dc at pin D, 28 volts dc at pin G and 28 volts dc at pin H of static inverter plug. If voltage is present at pins D, G, and H, and there is no voltage at pins A or B, replace inverter.
2. NO VOLTAGE AT PIN "G" OF INVERTER	
A. Defective wiring.	Open or shorted wire between pin G and static inverter limiter. Repair or replace wiring.
3. NO VOLTAGE AT PIN "H" OF INVERTER	
A. Faulty inverter.	Replace static inverter.
4. NO VOLTAGE AT PIN "D" OF INVERTER	
A. Defective wiring.	Check for voltage at terminal X1 of control relay. If no voltage repair or replace wiring between pin H of static inverter and terminal X1 of control relay. Check wiring for continuity between terminal X2 of control relay and control switch, between switch and ground. If no continuity repair or replace wiring.
B. Faulty control relay.	Check for continuity between terminals X1 and X2. If no continuity replace relay.
C. Faulty control switch.	Check control switch for continuity. If no continuity in ON position replace switch.

5. "EMER IGN PWR ON" LIGHT DOES NOT ILLUMINATE WITH STATIC INVERTER SYSTEM OPERATING

A. Burned out lamps.	Replace lamps and recheck operation.
B. Defective wiring.	Check wiring continuity between light and ground and between light and pin I of inverter. If no continuity repair or replace wiring.
C. Faulty relay in master warn circuit	Check for continuity between A2 and A3 with relay deenergized. If no continuity, replace relay.

6. ENGINE START SYSTEM DOES NOT OPERATE WITH STATIC INVERTER SYSTEM ON AND "EMER IGN PWR ON" LIGHT ILLUMINATED

A. Defective wiring.	Check for 115-volts ac at pins X1, A1 and C1 of the four engine inverter relays. If there is no voltage, repair or replace wiring between pin A of the static inverter and the above mentioned pins of the engine inverter relays. (Refer to Chapter 80, ENGINE STARTING)

7. EXHAUST GAS TEMPERATURE INDICATORS AND/OR FIRE DETECTOR SYSTEMS DO NOT OPERATE WITH STATIC INVERTER SYSTEM ON

A. Faulty relays.	Check for continuity between pins X1 and X2 for Exhaust Gas Temperature Ind and Fire Detector Transfer Relays. If no continuity, replace relay(s).
B. Defective wiring.	Check for power on input side of circuit breakers. If no power, check continuity between circuit breakers and relays, between relays and pins A and B of static inverter. Repair or replace defective wiring.

EMERGENCY AC STATIC INVERTER SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Emergency AC Static Inverter System

A. Equipment Required - AC-DC Voltmeter.

B. Preparation.

(1) Check the following control switches for the configuration indicated.

(a) Emergency ignition power switch - OFF RESET.

(b) Battery switch - BATT OFF.

(c) Essential bus relay switch - NORMAL.

(2) Check that the following circuit breakers are open:

(a) EXHAUST GAS TEMP IND - ENG 1, ENG 2, ENG 3 and ENG 4.

(b) FIRE DETECTOR SYSTEM - ENG 1, ENG 2, ENG 3 and ENG 4.

(c) HYD BRAKE PRESS

(d) FUEL FLOW AMPLIFIERS - ENG 1, ENG 2, ENG 3 and ENG 4.

(3) Check the following system warning lights for the configurations indicated.

(a) DC EMER BUS OFF light - extinguished.

(b) DC ESS BUS OFF light - extinguished.

(c) EMER IGN PWR ON light - extinguished.

(d) All other power indicator lights shall be extinguished.

(4) Gain access to rear of upper and lower inboard circuit breaker panels.

CAUTION: DO NOT OPERATE INVERTER FOR PERIODS EXCEEDING 12 MINUTES REGARDLESS OF LOAD. DEENERGIZE INVERTER AFTER TEST AND ALLOW A MINIMUM OF ONE HOUR BETWEEN OPERATIONS.

C. Test Emergency AC Static Inverter System.

(1) Actuate the battery switch to the EMER position. The DC ESS BUS OFF light and the CHARGER RELAY OPEN light shall illuminate.

(2) Actuate the EMER IGN PWR switch to ON. The EMER IGN PWR ON light shall illuminate and the battery ammeter shall indicate from 0 to -25 amperes.

(a) Check for 115-volts ac at the input side of the EXHAUST GAS TEMP IND circuit breakers.

(b) Check for 115-volts ac at the input side of the FUEL FLOW AMPLIFIERS circuit breakers.

(c) Check for 115-volts ac at the FIRE DETECTOR SYSTEM circuit breakers.

(d) Check for 26-volts ac at the HYD BRAKE PRESS circuit breaker.

(3) Actuate the EMER IGN PWR switch to OFF RESET position. The EMER IGN PWR ON light shall extinguish.

(4) Actuate the battery switch to BATT OFF position. The DC ESS BUS OFF light and the CHARGER RELAY OPEN light shall extinguish.

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